Shark® 100 & 100T

Upgradeable Fully Featured Power & Energy Meter

www.electroind.com

Installation & Operation Manual
V.1.18
September 15, 2011

Electro Industries/GaugeTech
The Leader In Power Monitoring and Smart Grid Solutions

1800 Shames Drive, Westbury, NY 11590 Tel: (516) 334-0870 Fax: (516) 338-4741 Email: sales@electroind.com

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Published by:

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1800 Shames Drive

Westbury, NY 11590

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Customer Service and Support

Customer support is available 9:00 am to 4:30 pm, Eastern Standard Time, Monday through Friday. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have all meter readings available. When returning any merchandise to EIG, a return materials authorization number is required. For customer or technical assistance, repair or calibration, phone 516-334-0870 or fax 516-338-4741.

Product Warranty

Electro Industries/GaugeTech warrants all products to be free from defects in material and workmanship for a period of four years from the date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, fax or call our customer-support department. You will receive prompt assistance and return instructions. Send the instrument, transportation prepaid, to EIG at 1800 Shames Drive, Westbury, NY 11590. Repairs will be made and the instrument will be returned.

This warranty does not apply to defects resulting from unauthorized modification, misuse, or use for any reason other than electrical power monitoring. The Shark® 100/100T meter is not a user-serviceable product.

OUR PRODUCTS ARE NOT TO BE USED FOR PRIMARY OVER-CURRENT PROTECTION. ANY PROTECTION FEATURE IN OUR PRODUCTS IS TO BE USED FOR ALARM OR SECONDARY PROTECTION ONLY.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ELECTRO INDUSTRIES/ GAUGETECH SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING FROM ANY AUTHORIZED OR UNAUTHORIZED USE OF ANY ELECTRO INDUSTRIES/GAUGETECH PRODUCT. LIABILITY SHALL BE LIMITED TO THE ORIGINAL COST OF THE PRODUCT SOLD.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by Electro Industries/GaugeTech. The accuracy and a calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards.

Disclaimer

The information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.

This symbol indicates that the operator must refer to an explanation in the operating instructions. Please see Chapter 4 for important safety information regarding installation and hookup of the Shark® 100/100T meter.

About Electro Industries/GaugeTech

Founded in 1975 by engineer and inventor Dr. Samuel Kagan, Electro Industries/GaugeTech changed the face of power monitoring forever with its first breakthrough innovation: an affordable, easy-to-use AC power meter. A few of our many technology firsts include:

- 1975: First multifunction meter
- 1981: First micro-processor based power monitor
- 1986: First PC-based power monitoring software for plant-wide power distribution analysis
- 1994: First 1 MegaByte memory high-performance power monitor for data analysis and recording
- 1999: First auto-calibrating power monitoring - Nexus® Series
- 2001: First auto-calibrating meter under glass
- 2005: Shark® 100 submeter and Shark® 100S wireless submeter with 802.11 WiFi capability
- 2007: Shark® 200 data-logging sub-meter with optional I/O
- 2008: First Nexus® 1500 transient recorder and power meter with advanced PQ and dual Ethernet communication ports

Thirty years since its founding, Electro Industries/GaugeTech, the leader in power monitoring and control, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2000 certified company, EIG sets the industry standard for advanced power quality and reporting, revenue metering and substation data acquisition and control. EIG products can be found on site at virtually all of today's leading manufacturers, industrial giants and utilities.

All EIG products are designed, manufactured, tested and calibrated at our facility in Westbury, New York.

Applications

- Web-accessed multifunction power monitoring and control
- Single and multifunction power monitoring
- Power quality monitoring
- Onboard data logging for trending power usage and quality
- Disturbance analysis
- Revenue metering and billing
- Smart grid solutions

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1: Three-Phase Power Measurement

This introduction to three-phase power and power measurement is intended to provide only a brief overview of the subject. The professional meter engineer or meter technician should refer to more advanced documents such as the EEI Handbook for Electricity Metering and the application standards for more in-depth and technical coverage of the subject.

1.1: Three-Phase System Configurations

Three-phase power is most commonly used in situations where large amounts of power will be used because it is a more effective way to transmit the power and because it provides a smoother delivery of power to the end load. There are two commonly used connections for three-phase power, a wye connection or a delta connection. Each connection has several different manifestations in actual use.

When attempting to determine the type of connection in use, it is a good practice to follow the circuit back to the transformer that is serving the circuit. It is often not possible to conclusively determine the correct circuit connection simply by counting the wires in the service or checking voltages. Checking the transformer connection will provide conclusive evidence of the circuit connection and the relationships between the phase voltages and ground.

1.1.1: Wye Connection

The wye connection is so called because when you look at the phase relationships and the winding relationships between the phases it looks like a Y. Figure 1.1 depicts the winding relationships for a wye-connected service. In a wye service the neutral (or center point of the wye) is typically grounded. This leads to common voltages of 208/120 and 480/277 (where the first number represents the phase-to-phase voltage and the second number represents the phase-to-ground voltage).

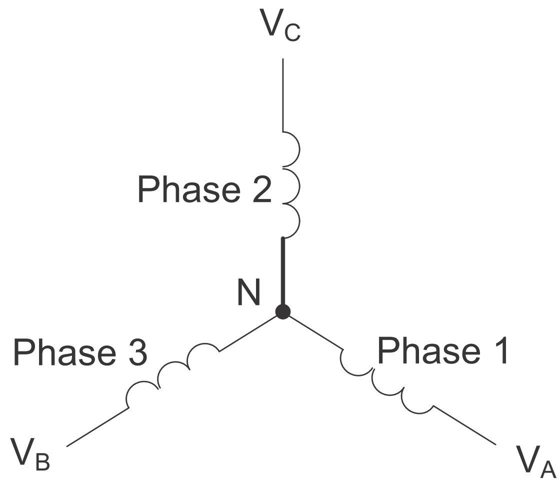


Figure 1.1: Three-phase Wye Winding

The three voltages are separated by 120^o electrically. Under balanced load conditions the currents are also separated by 120^o. However, unbalanced loads and other conditions can cause the currents to depart from the ideal 120^o separation. Three-phase voltages and currents are usually represented with a phasor diagram. A phasor diagram for the typical connected voltages and currents is shown in Figure 1.2.

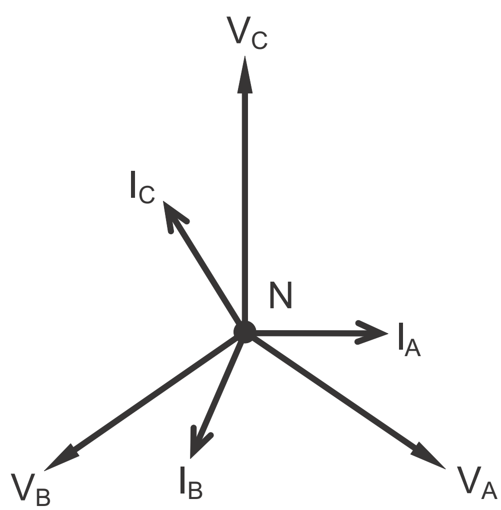


Figure 1.2: Phasor Diagram Showing Three-phase Voltages and Currents

The phasor diagram shows the 120^o angular separation between the phase voltages. The phase-to-phase voltage in a balanced three-phase wye system is 1.732 times the phase-to-neutral voltage. The center point of the wye is tied together and is typically grounded. Table 1.1 shows the common voltages used in the United States for wye-connected systems.

Phase to Ground Voltage	Phase to Phase Voltage
120 volts	208 volts
277 volts	480 volts
2,400 volts	4,160 volts
7,200 volts	12,470 volts
7,620 volts	13,200 volts

Table 1: Common Phase Voltages on Wye Services

Usually a wye-connected service will have four wires: three wires for the phases and one for the neutral. The three-phase wires connect to the three phases (as shown in Figure 1.1). The neutral wire is typically tied to the ground or center point of the wye.

In many industrial applications the facility will be fed with a four-wire wye service but only three wires will be run to individual loads. The load is then often referred to as a delta-connected load but the service to the facility is still a wye service; it contains four wires if you trace the circuit back to its source (usually a transformer). In this type of connection the phase to ground voltage will be the phase-to-ground voltage indicated in Table 1, even though a neutral or ground wire is not physically present at the load. The transformer is the best place to determine the circuit connection type because this is a location where the voltage reference to ground can be conclusively identified.

1.1.2: Delta Connection

Delta-connected services may be fed with either three wires or four wires. In a three-phase delta service the load windings are connected from phase-to-phase rather than from phase-to-ground. Figure 1.3 shows the physical load connections for a delta service.

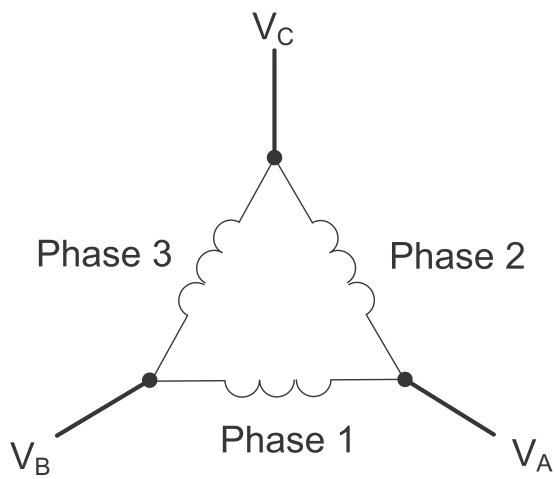


Figure 1.3: Three-phase Delta Winding Relationship

In this example of a delta service, three wires will transmit the power to the load. In a true delta service, the phase-to-ground voltage will usually not be balanced because the ground is not at the center of the delta.

Figure 1.4 shows the phasor relationships between voltage and current on a three-phase delta circuit.

In many delta services, one corner of the delta is grounded. This means the phase to ground voltage will be zero for one phase and will be full phase-to-phase voltage for the other two phases. This is done for protective purposes.

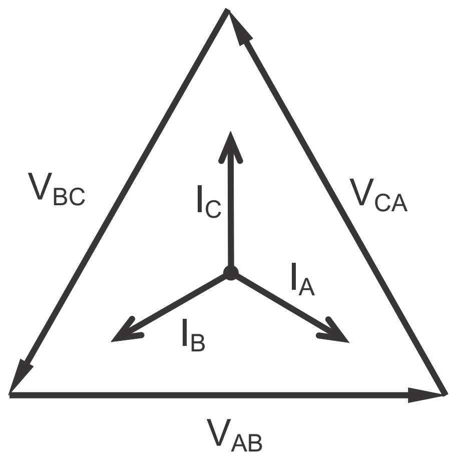


Figure 1.4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

Another common delta connection is the four-wire, grounded delta used for lighting loads. In this connection the center point of one winding is grounded. On a 120/240 volt, four-wire, grounded delta service the phase-to-ground voltage would be 120 volts on two phases and 208 volts on the third phase. Figure 1.5 shows the phasor diagram for the voltages in a three-phase, four-wire delta system.

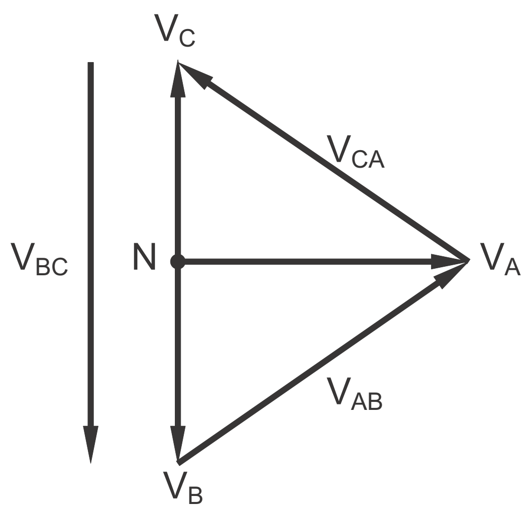


Figure 1.5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

1.1.3: Blondell's Theorem and Three Phase Measurement

In 1893 an engineer and mathematician named Andre E. Blondell set forth the first scientific basis for polyphase metering. His theorem states:

If energy is supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of the readings of N wattmeters so arranged that each of the N wires contains one current coil, the corresponding potential coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 Wattmeters.

The theorem may be stated more simply, in modern language:

In a system of N conductors, N-1 meter elements will measure the power or energy taken provided that all the potential coils have a common tie to the conductor in which there is no current coil.

Three-phase power measurement is accomplished by measuring the three individual phases and adding them together to obtain the total three phase value. In older analog meters, this measurement was accomplished using up to three separate elements. Each element combined the single-phase voltage and current to produce a torque on the meter disk. All three elements were arranged around the disk so that the disk was subjected to the combined torque of the three elements. As a result the disk would turn at a higher speed and register power supplied by each of the three wires.

According to Blondell's Theorem, it was possible to reduce the number of elements under certain conditions. For example, a three-phase, three-wire delta system could be correctly measured with two elements (two potential coils and two current coils) if the potential coils were connected between the three phases with one phase in common.

In a three-phase, four-wire wye system it is necessary to use three elements. Three voltage coils are connected between the three phases and the common neutral conductor. A current coil is required in each of the three phases.

In modern digital meters, Blondell's Theorem is still applied to obtain proper metering. The difference in modern meters is that the digital meter measures each phase voltage and current and calculates the single-phase power for each phase. The meter then sums the three phase powers to a single three-phase reading.

Some digital meters calculate the individual phase power values one phase at a time. This means the meter samples the voltage and current on one phase and calculates a power value. Then it samples the second phase and calculates the power for the second phase. Finally, it samples the third phase and calculates that phase power. After sampling all three phases, the meter combines the three readings to create the equivalent three-phase power value. Using mathematical averaging techniques, this method can derive a quite accurate measurement of three-phase power.

More advanced meters actually sample all three phases of voltage and current simultaneously and calculate the individual phase and three-phase power values. The advantage of simultaneous sampling is the reduction of error introduced due to the difference in time when the samples were taken.

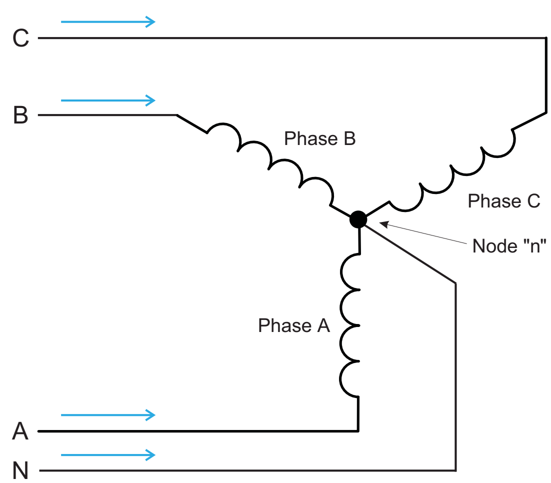


Figure 1.6: Three-Phase Wye Load Illustrating Kirchhoff’s Law and Blondell’s Theorem

Blondell's Theorem is a derivation that results from Kirchhoff's Law. Kirchhoff's Law states that the sum of the currents into a node is zero. Another way of stating the same thing is that the current into a node (connection point) must equal the current out of the node. The law can be applied to measuring three-phase loads. Figure 1.6 shows a typical connection of a three-phase load applied to a three-phase, four-wire service. Krichhoff's Law holds that the sum of currents A, B, C and N must equal zero or that the sum of currents into Node "n" must equal zero.

If we measure the currents in wires A, B and C, we then know the current in wire N by Kirchhoff's Law and it is not necessary to measure it. This fact leads us to the conclusion of Blondell's Theorem- that we only need to measure the power in three of

the four wires if they are connected by a common node. In the circuit of Figure 1.6 we must measure the power flow in three wires. This will require three voltage coils and three current coils (a three-element meter). Similar figures and conclusions could be reached for other circuit configurations involving Delta-connected loads.

1.2: Power, Energy and Demand

It is quite common to exchange power, energy and demand without differentiating between the three. Because this practice can lead to confusion, the differences between these three measurements will be discussed.

Power is an instantaneous reading. The power reading provided by a meter is the present flow of watts. Power is measured immediately just like current. In many digital meters, the power value is actually measured and calculated over a one second interval because it takes some amount of time to calculate the RMS values of voltage and current. But this time interval is kept small to preserve the instantaneous nature of power.

Energy is always based on some time increment; it is the integration of power over a defined time increment. Energy is an important value because almost all electric bills are based, in part, on the amount of energy used.

Typically, electrical energy is measured in units of kilowatt-hours (kWh). A kilowatt-hour represents a constant load of one thousand watts (one kilowatt) for one hour. Stated another way, if the power delivered (instantaneous watts) is measured as 1,000 watts and the load was served for a one hour time interval then the load would have absorbed one kilowatt-hour of energy. A different load may have a constant power requirement of 4,000 watts. If the load were served for one hour it would absorb four kWh. If the load were served for 15 minutes it would absorb ¼ of that total or one kWh.

Figure 1.7 shows a graph of power and the resulting energy that would be transmitted as a result of the illustrated power values. For this illustration, it is assumed that the power level is held constant for each minute when a measurement is taken. Each bar in the graph will represent the power load for the one-minute increment of time. In real life the power value moves almost constantly.

The data from Figure 1.7 is reproduced in Table 2 to illustrate the calculation of energy. Since the time increment of the measurement is one minute and since we

specified that the load is constant over that minute, we can convert the power reading to an equivalent consumed energy reading by multiplying the power reading times 1/60 (converting the time base from minutes to hours).

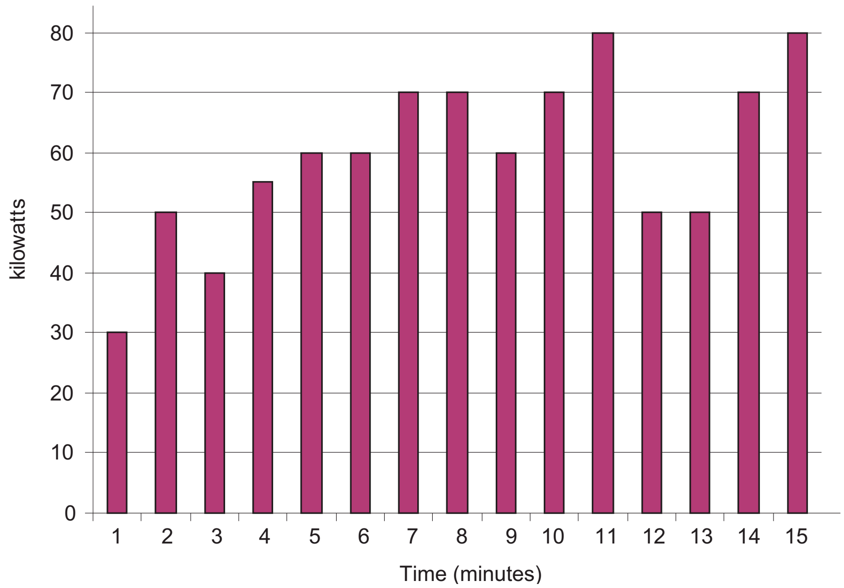


Figure 1.7: Power Use over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
1	30	0.50	0.50
2	50	0.83	1.33
3	40	0.67	2.00
4	55	0.92	2.92
5	60	1.00	3.92
6	60	1.00	4.92
7	70	1.17	6.09
8	70	1.17	7.26
9	60	1.00	8.26
10	70	1.17	9.43
11	80	1.33	10.76
12	50	0.83	12.42
13	50	0.83	12.42
14	70	1.17	13.59
15	80	1.33	14.92

Table 1.2: Power and Energy Relationship over Time

As in Table 1.2, the accumulated energy for the power load profile of Figure 1.7 is 14.92 kWh.

Demand is also a time-based value. The demand is the average rate of energy use over time. The actual label for demand is kilowatt-hours/hour but this is normally reduced to kilowatts. This makes it easy to confuse demand with power, but demand is not an instantaneous value. To calculate demand it is necessary to accumulate the energy readings (as illustrated in Figure 1.7) and adjust the energy reading to an hourly value that constitutes the demand.

In the example, the accumulated energy is 14.92 kWh. But this measurement was made over a 15-minute interval. To convert the reading to a demand value, it must be normalized to a 60-minute interval. If the pattern were repeated for an additional three 15-minute intervals the total energy would be four times the measured value or

59.68 kWh. The same process is applied to calculate the 15-minute demand value. The demand value associated with the example load is 59.68 kWh/hr or 59.68 kWd. Note that the peak instantaneous value of power is 80 kW, significantly more than the demand value.

Figure 1.8 shows another example of energy and demand. In this case, each bar represents the energy consumed in a 15-minute interval. The energy use in each interval typically falls between 50 and 70 kWh. However, during two intervals the energy rises sharply and peaks at 100 kWh in interval number 7. This peak of usage will result in setting a high demand reading. For each interval shown the demand value would be four times the indicated energy reading. So interval 1 would have an associated demand of 240 kWh/hr. Interval 7 will have a demand value of 400 kWh/hr. In the data shown, this is the peak demand value and would be the number that would set the demand charge on the utility bill.

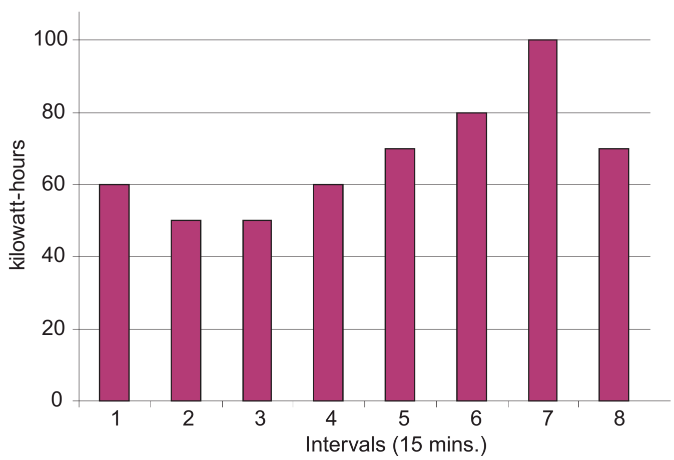


Figure 1.8: Energy Use and Demand

As can be seen from this example, it is important to recognize the relationships between power, energy and demand in order to control loads effectively or to monitor use correctly.

1.3: Reactive Energy and Power Factor

The real power and energy measurements discussed in the previous section relate to the quantities that are most used in electrical systems. But it is often not sufficient to only measure real power and energy. Reactive power is a critical component of the total power picture because almost all real-life applications have an impact on reactive power. Reactive power and power factor concepts relate to both load and generation applications. However, this discussion will be limited to analysis of reactive power and power factor as they relate to loads. To simplify the discussion, generation will not be considered.

Real power (and energy) is the component of power that is the combination of the voltage and the value of corresponding current that is directly in phase with the voltage. However, in actual practice the total current is almost never in phase with the voltage. Since the current is not in phase with the voltage, it is necessary to consider both the inphase component and the component that is at quadrature (angularly rotated 90^o or perpendicular) to the voltage. Figure 1.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

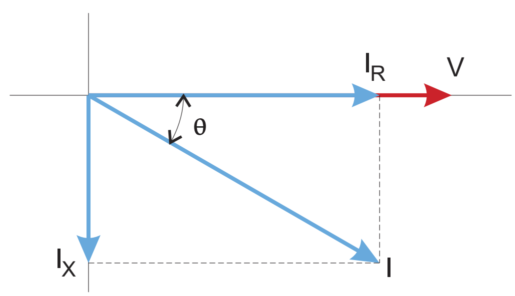


Figure 1.9: Voltage and Complex Current

The voltage (V) and the total current (I) can be combined to calculate the apparent power or VA. The voltage and the in-phase current (I_R) are combined to produce the real power or watts. The voltage and the quadrature current (I_X) are combined to calculate the reactive power.

The quadrature current may be lagging the voltage (as shown in Figure 1.9) or it may lead the voltage. When the quadrature current lags the voltage the load is requiring both real power (watts) and reactive power (VARs). When the quadrature current

leads the voltage the load is requiring real power (watts) but is delivering reactive power (VARs) back into the system; that is VARs are flowing in the opposite direction of the real power flow.

Reactive power (VARs) is required in all power systems. Any equipment that uses magnetization to operate requires VARs. Usually the magnitude of VARs is relatively low compared to the real power quantities. Utilities have an interest in maintaining VAR requirements at the customer to a low value in order to maximize the return on plant invested to deliver energy. When lines are carrying VARs, they cannot carry as many watts. So keeping the VAR content low allows a line to carry its full capacity of watts. In order to encourage customers to keep VAR requirements low, some utilities impose a penalty if the VAR content of the load rises above a specified value.

A common method of measuring reactive power requirements is power factor. Power factor can be defined in two different ways. The more common method of calculating power factor is the ratio of the real power to the apparent power. This relationship is expressed in the following formula:

Total PF = real power / apparent power = watts/VA

This formula calculates a power factor quantity known as Total Power Factor. It is called Total PF because it is based on the ratios of the power delivered. The delivered power quantities will include the impacts of any existing harmonic content. If the voltage or current includes high levels of harmonic distortion the power values will be affected. By calculating power factor from the power values, the power factor will include the impact of harmonic distortion. In many cases this is the preferred method of calculation because the entire impact of the actual voltage and current are included.

A second type of power factor is Displacement Power Factor. Displacement PF is based on the angular relationship between the voltage and current. Displacement power factor does not consider the magnitudes of voltage, current or power. It is solely based on the phase angle differences. As a result, it does not include the impact of

harmonic distortion. Displacement power factor is calculated using the following equation:

$$\text{Displacement PF} = \cos\theta$$

where θ is the angle between the voltage and the current (see Fig. 1.9).

In applications where the voltage and current are not distorted, the Total Power Factor will equal the Displacement Power Factor. But if harmonic distortion is present, the two power factors will not be equal.

1.4: Harmonic Distortion

Harmonic distortion is primarily the result of high concentrations of non-linear loads. Devices such as computer power supplies, variable speed drives and fluorescent light ballasts make current demands that do not match the sinusoidal waveform of AC electricity. As a result, the current waveform feeding these loads is periodic but not sinusoidal. Figure 1.10 shows a normal, sinusoidal current waveform. This example has no distortion.

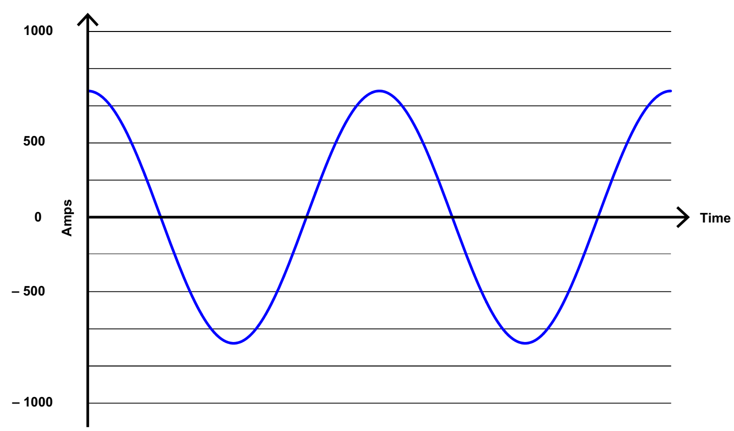


Figure 1.10: Nondistorted Current Waveform

Figure 1.11 shows a current waveform with a slight amount of harmonic distortion. The waveform is still periodic and is fluctuating at the normal 60 Hz frequency. However, the waveform is not a smooth sinusoidal form as seen in Figure 1.10.

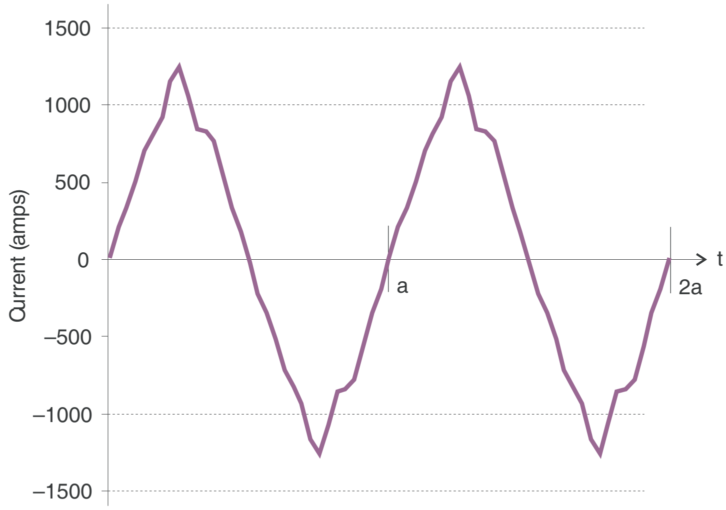


Figure 1.11: Distorted Current Waveform

The distortion observed in Figure 1.11 can be modeled as the sum of several sinusoidal waveforms of frequencies that are multiples of the fundamental 60 Hz frequency. This modeling is performed by mathematically disassembling the distorted waveform into a collection of higher frequency waveforms.

These higher frequency waveforms are referred to as harmonics. Figure 1.12 shows the content of the harmonic frequencies that make up the distortion portion of the waveform in Figure 1.11.

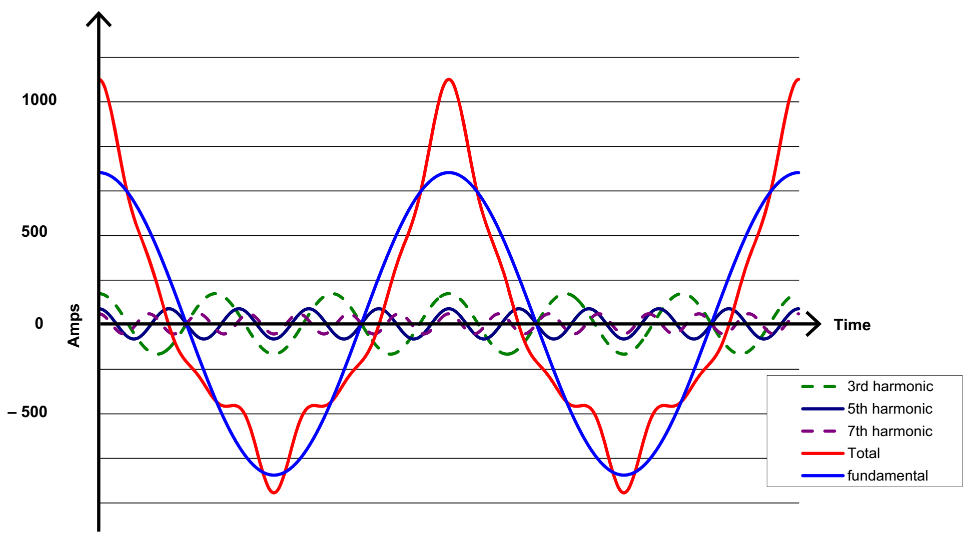


Figure 1.12: Waveforms of the Harmonics

The waveforms shown in Figure 1.12 are not smoothed but do provide an indication of the impact of combining multiple harmonic frequencies together.

When harmonics are present it is important to remember that these quantities are operating at higher frequencies. Therefore, they do not always respond in the same manner as 60 Hz values.

Inductive and capacitive impedance are present in all power systems. We are accustomed to thinking about these impedances as they perform at 60 Hz. However, these impedances are subject to frequency variation.

$X_L = j\omega L$ and

$X_C = 1/j\omega C$

At 60 Hz, ω = 377; but at 300 Hz (5th harmonic) ω = 1,885. As frequency changes impedance changes and system impedance characteristics that are normal at 60 Hz may behave entirely differently in the presence of higher order harmonic waveforms.

Traditionally, the most common harmonics have been the low order, odd frequencies, such as the 3rd, 5th, 7th, and 9th. However newer, new-linear loads are introducing significant quantities of higher order harmonics.

Since much voltage monitoring and almost all current monitoring is performed using instrument transformers, the higher order harmonics are often not visible. Instrument transformers are designed to pass 60 Hz quantities with high accuracy. These devices, when designed for accuracy at low frequency, do not pass high frequencies with high accuracy; at frequencies above about 1200 Hz they pass almost no information. So when instrument transformers are used, they effectively filter out higher frequency harmonic distortion making it impossible to see.

However, when monitors can be connected directly to the measured circuit (such as direct connection to a 480 volt bus) the user may often see higher order harmonic distortion. An important rule in any harmonics study is to evaluate the type of equipment and connections before drawing a conclusion. Not being able to see harmonic distortion is not the same as not having harmonic distortion.

It is common in advanced meters to perform a function commonly referred to as waveform capture. Waveform capture is the ability of a meter to capture a present picture of the voltage or current waveform for viewing and harmonic analysis.

Typically a waveform capture will be one or two cycles in duration and can be viewed as the actual waveform, as a spectral view of the harmonic content, or a tabular view showing the magnitude and phase shift of each harmonic value. Data collected with waveform capture is typically not saved to memory. Waveform capture is a real-time data collection event.

Waveform capture should not be confused with waveform recording that is used to record multiple cycles of all voltage and current waveforms in response to a transient condition.

1.5: Power Quality

Power quality can mean several different things. The terms "power quality" and "power quality problem" have been applied to all types of conditions. A simple definition of "power quality problem" is any voltage, current or frequency deviation that results in mis-operation or failure of customer equipment or systems. The causes of power quality problems vary widely and may originate in the customer equipment, in an adjacent customer facility or with the utility.

In his book Power Quality Primer, Barry Kennedy provided information on different types of power quality problems. Some of that information is summarized in Table 1.3.

Cause	Disturbance Type	Source
Impulse transient	Transient voltage disturbance, sub-cycle duration	Lightning Electrostatic discharge Load switching Capacitor switching
Oscillatory transient with decay	Transient voltage, sub-cycle duration	Line/cable switching Capacitor switching Load switching
Sag/swell	RMS voltage, multiple cycle duration	Remote system faults
Interruptions	RMS voltage, multiple seconds or longer duration	System protection Circuit breakers Fuses Maintenance
Under voltage/over voltage	RMS voltage, steady state, multiple seconds or longer duration	Motor starting Load variations Load dropping
Voltage flicker	RMS voltage, steady state, repetitive condition	Intermittent loads Motor starting Arc furnaces
Harmonic distortion	Steady state current or voltage, long-term duration	Non-linear loads System resonance

Table 1.3: Typical Power Quality Problems and Sources

It is often assumed that power quality problems originate with the utility. While it is true that may power quality problems can originate with the utility system, many problems originate with customer equipment. Customer-caused problems may manifest themselves inside the customer location or they may be transported by the utility system to another adjacent customer. Often, equipment that is sensitive to power quality problems may in fact also be the cause of the problem.

If a power quality problem is suspected, it is generally wise to consult a power quality professional for assistance in defining the cause and possible solutions to the problem.

2: Meter Overview and Specifications

2.1: Hardware Overview

The Shark ® 100 monitor is a multifunction power meter designed to be used in electrical substations, panel boards and as a power meter for OEM equipment. The unit provides multifunction measurement of all electrical parameters.

The unit is designed with advanced measurement capabilities, allowing it to achieve high performance accuracy. The Shark 100® meter is specified as a 0.2% class energy meter for billing applications as well as a highly accurate panel indication meter.

Figure 2.1: Shark® 100 Meter

The Shark® 100 meter provides a host of additional capabilities, including either standard RS485 Modbus or RJ45 Ethernet, DNP Protocols and an IrDA port for panel-mount interrogation.

Shark® 100 meter features that are detailed in this manual are as follows:

- 0.2% Class Revenue Certifiable Energy and Demand metering
- Meets ANSI C12.20 (0.2%) and IEC 62053-22 (0.2%) accuracy classes
- Multifunction measurement including voltage, current, power, frequency, energy, etc.
- Power Quality measurements (%THD and Alarm Limits)
- V-Switch™ technology - field upgrade without removing installed meter
- Percentage of Load bar for analog meter perception
- Easy to use faceplate programming
- IrDA port for laptop PC reading and programming

- RS485 or RJ45 Modbus communication

The Shark® 100 comes in either of two models - the Meter/Transducer or the Transducer only.

Shark® 100 Meter/Digital Transducer

Meter and transducer in one compact unit. Features an IrDA port as well as either an RS485 or RJ45 port, and can be programmed using the faceplate of the meter. ANSI or DIN mounting may be used (see Figure 2.1).

Shark® 100T Digital Transducer

A Digital Transducer only unit providing either RS485 or RJ45 communication via Modbus RTU, Modbus ASCII and DNP 3.0 (V-3 and V-4) protocols. The unit is designed to install using DIN Rail Mounting (see Section 3.4).

Figure 2.2: Digital Transducer Only Model

2.1.1: Voltage and Current Inputs

Universal Voltage Inputs

Voltage inputs allow measurement to 416 Volts Line-to-Neutral and 721 Volts Line-to-Line. This insures proper meter safety when wiring directly to high Voltage systems. One unit will perform to specification on 69 Volt, 120 Volt, 230 Volt, 277 Volt, 277 Volt and 347 Volt power systems.

Current Inputs

The Shark® 100 meter's current inputs use a unique dual input method:

Method 1: CT Pass Through

The CT passes directly through the meter without any physical termination on the meter. This insures that the meter cannot be a point of failure on the CT circuit. This is preferable for utility users when sharing relay class CTs. No Burden is added to the secondary CT circuit.

Method 2: Current "Gills"

The unit additionally provides ultra-rugged termination pass through bars that allow CT leads to be terminated on the meter. This, too, eliminates any possible point of failure at the meter. This is a preferred technique for insuring that relay class CT integrity is not compromised (the CT will not open in a fault condition).

2.1.2: Model Number plus Option Numbers

Model	Freq.	Current Class	V-Switch™ Pack	Power Supply	COM (Meter Only)	Mounting (Meter Only)
Shark 100 Meter/ Transducer	50 50 Hz System	10 5 Amp Secondary	V1 Default V-Switch™ Volts/ Amps	D2 90-265V AC/DC	X No Com	X ANSI Mounting
Shark 100T Transducer Only	60 60 Hz System	2 1 Amp Secondary	V2 above with Power and Freq	D 24-48V DC	485P RS485 + Pulse (Standard in Trans-ducer Only)	DIN DIN Mounting
			V3 above with DNP 3.0 and Energy Counters		INP10 10/100 BaseT Ethernet	
			V4 above with Har-monics and Limits			

Example:

Shark 100 - 60 -10 -V2 -D -X -X

which translates to a Shark 100 meter/transducer, with 60Hz system, Class 10, V-2 V-Switch™ key, 24-48VDC power supply, no optional Com, and ANSI Mounting.

2.1.3: V-Switch™ Technology

EIG's exclusive V-Switch™ Technology is a virtual firmware-based switch that lets you enable meter features through communication. This allows the Shark® 100 unit to be upgraded after installation to a higher model without removing the unit from service.

Available V-Switch™ Keys

V-Switch™ Key 1 (V-1): Volts and Amps Meter - Default

V-Switch™ Key 2 (V-2): Volts, Amps, kW, kVAR, PF, kVA, Freq

V-Switch™ Key 3 (V-3): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh & DNP 3.0

V-Switch™ Key 4 (V-4): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, %THD Monitoring, Limit Exceeded Alarms and DNP 3.0

Obtaining a V-Switch™ Key:

Contact EIG's inside sales staff at sales@electroind.com or by calling (516) 334-0870 (USA) and provide the following information:

1. Serial Number or Numbers of the meters you are upgrading. Use the number(s), with leading zeros, shown in the Communicator EXT Device Status screen (from the Communicator EXT Main screen, click **Tools>Device Status**).

2. Desired V-Switch™ key.

3. Credit Card or Purchase Order Number. EIG will issue you the V-Switch™ key.

Enabling the V-Switch™ Key:

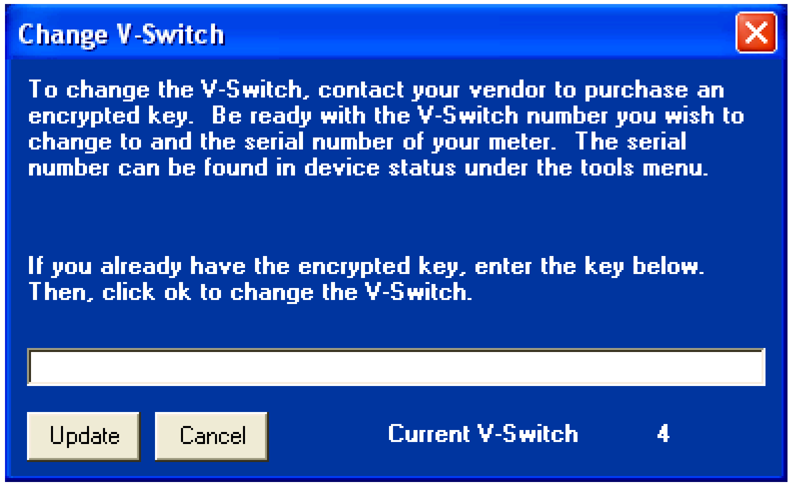
1. Open Communicator EXT.

2. Power up your meter.

3. Connect to the Shark® 100 meter through Communicator EXT (see Chapter 5).

4. Click **Tools>Change V-Switch** from the Title Bar. A screen opens, requesting the encrypted key. Enter the V-Switch™ key provided by EIG.

5. Click the **OK** button. The V-Switch™ key is enabled and the meter is reset.



NOTE: For more details on software configuration, refer to the *Communicator EXT Users Manual*.

2.1.4: Measured Values

The following table lists the measured values available in Real Time, Average, Maximum, and Minimum.

Meter's Measured Values				
Measured Values	**Real Time**	**Average**	**Max**	**Min**
Voltage L-N	X		X	X
Voltage L-L	X		X	X
Current per Phase	X	X	X	X
Current Neutral	X			
Watts	X	X	X	X
VAR	X	X	X	X
VA	X	X	X	X
PF	X	X	X	X
+Watt-hr	X			
-Watt-hr	X			
Watt-hr Net	X			
+VAR-hr	X			
-VAR-hr	X			
VAR-hr Net	X			
VA-hr	X			
Frequency	X		X	X
**%THD	X		X	X
Voltage Angles	X			
Current Angles	X			
% of Load Bar	X			

** The Shark® 100 meter measures harmonics up to the 7th order for current and up to the 3rd order for voltage.

2.1.5: Utility Peak Demand

The Shark® 100 meter provides user-configured Block (Fixed) window or Rolling window Demand. This feature allows you to set up a customized Demand profile. Block window Demand is Demand used over a user-configured demand period (usually 5, 15 or 30 minutes). Rolling Window Demand is a fixed window demand that moves for a user-specified subinterval period. For example, a 15-minute Demand using 3 subintervals and providing a new Demand reading every 5 minutes, based on the last 15 minutes.

Utility Demand features can be used to calculate kW, kVAR, kVA and PF readings. All other parameters offer Max and Min capability over the user-selectable averaging period. Voltage provides an instantaneous Max and Min reading which displays the highest surge and lowest sag seen by the meter.

2.2: Specifications

Power Supply

Range:	D2 Option: Universal, (90 to 265) VAC @50/60Hz or (100 to 370)VDC D Option: (18-60) VDC
Power Consumption:	5 VA, 3.5W

Voltage Inputs (Measurement Category III)

Range:	Universal, Auto-ranging up to 416VAC L-N, 721VAC L-L
Supported hookups:	3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 Wire Delta
Input Impedance:	1M Ohm/Phase
Burden:	0.0144VA/Phase at 120 Volts
Pickup Voltage:	10Vac
Connection:	Screw terminal (Diagram 4.4)
Max Input Wire Gauge:	AWG#12 / 2.5mm^2

Fault Withstand:	Meets IEEE C37.90.1
Reading:	Programmable Full Scale to any PT Ratio

Current Inputs

Class 10:	5A Nominal, 10A Maximum
Class 2:	1A Nominal, 2A Maximum
Burden:	0.005VA Per Phase Max at 11 Amps
Pickup Current:	0.1% of Nominal
Connections:	O or U Lug Electrical Connection (Figure 4.1)
	Pass through Wire, 0.177" / 4.5mm Maximum Diameter (Figure 4.2)
	Quick Connect, 0.25" Male Tab (Figure 4.3)
Fault Withstand (at 23° C):	100A/10sec., 300A/3sec., 500A/1sec.
Reading:	Programmable Full Scale to any CT Ratio

Isolation

All Inputs and Outputs are galvanically isolated to 2500 VAC

Environmental Rating

Storage:	(-20 to +70)° C
Operating:	(-20 to +70)° C
Humidity:	to 95% RH Non-condensing
Faceplate Rating:	NEMA12 (Water Resistant), Mounting Gasket Included

Measurement Methods

Voltage, Current:	True RMS
Power:	Sampling at 400+ Samples per Cycle on All Channels Measured Readings Simultaneously
A/D Conversion:	6 Simultaneous 24 bit Analog to Digital Converters

Update Rate

Watts, VAR and VA:	100 milliseconds (Ten times per second)
All other parameters:	1 second

Communication Format

1. RS485 or RJ45Port through Back Plate

2. IrDA Port through Face Plate

3. RS485P or INP10- RS485 or RJ45 plus KYZ Pulse

Protocols:	Modbus RTU, Modbus ASCII, DNP 3.0 (V-3 and V-4)
Com Port Baud Rate:	9,600 to 57,600 b/s
Com Port Address:	001-247
Data Format:	8 Bit, No Parity
Shark ®100T Transducer	Default Initial Communication Baud 9600 (see Chapter 5)

Mechanical Parameters

Dimensions:	(Height 4.85 x Width 4.85 x Depth 4.65) inches, (H 12.32 x W 12.32 x D 11.81) cm

Mounts in 92mm square DIN or ANSI C39.1, 4" Round Cut-out

Weight:	2 pounds, 0.907kg (ships in a 6"/ 152.4mm cube container)

KYZ/RS485 Port Specifications

RS485 Transceiver; meets or exceeds EIA/TIA-485 Standard:

Type:	Two-wire, half duplex
Min. Input Impedance:	96kΩ
Max. Output Current:	±60mA

Wh Pulse

KYZ output contacts (and infrared LED light pulses through face plate): (See Section 6.4 for Kh values.)

Pulse Width:	40ms
Full Scale Frequency:	~6Hz
Contact type:	Solid State – SPDT (NO – C – NC)
Relay type:	Solid state
Peak switching voltage:	DC ±350V
Continuous load current:	120mA
Peak load current:	350mA for 10ms
On resistance, max.:	35Ω
Leakage current:	1µA@350V
Isolation:	AC 3750V

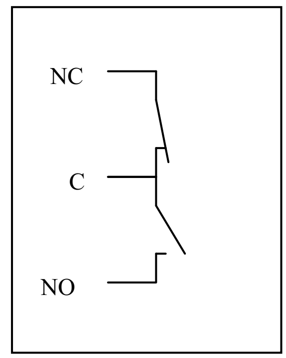
Reset State: (NC - C) Closed; (NO - C) Open

Infrared LED:

Peak Spectral Wavelength: 940nm

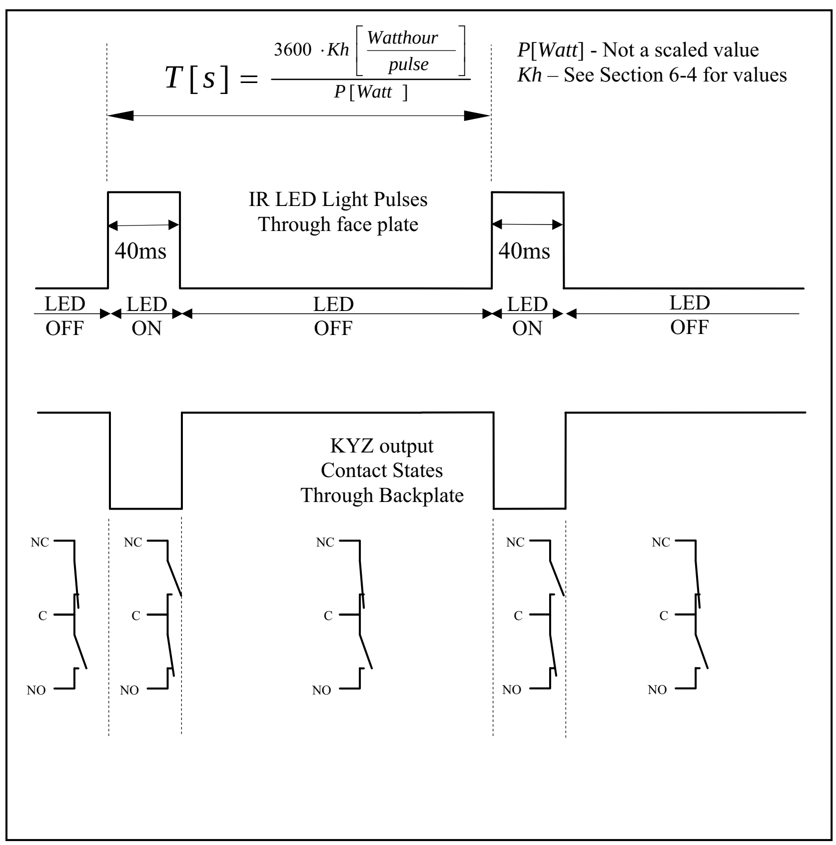
Reset State: Off

Internal Schematic:



(De-energized state)

Output timing:



2.3: Compliance

- IEC 62053-22 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- IEC1000-4-2: ESD
- IEC1000-4-3: Radiated Immunity
- IEC1000-4-4: Fast Transient
- IEC1000-4-5: Surge Immunity
- UL Listed
- CE Compliant

2.4: Accuracy

For 23° C, 3 Phase balanced Wye or Delta load, at 50 or 60 Hz (as per order), 5A (Class 10) nominal unit:

Parameter	Accuracy	Accuracy Input Range
Voltage L-N [V]	0.1% of reading[2]	(69 to 480)V
Voltage L-L [V]	0.1% of reading	(120 to 600)V
Current Phase [A]	0.1% of reading[1]	(0.15 to 5)A
Current Neutral (calculated) [A]	2.0% of Full Scale[1]	(0.15 to 5)A @ (45 to 65)Hz
Active Power Total [W]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Active Energy Total [Wh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Reactive Power Total [VAR]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF
Reactive Energy Total [VARh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF
Apparent Power Total [VA]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Apparent Energy Total [VAh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Power Factor	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Frequency	+/- 0.01Hz	(45 to 65)Hz
Total Harmonic Distortion (%)	5.0%[1]	(0.5 to 10)A or (69 to 480)V, measurement range (1 to 99.99)%
Load Bar	+/- 1 segment	(0.005 to 6)A

[1] For 2.5 element programmed units, degrade accuracy by an additional 0.5% of reading.

- For 1A (Class 2) Nominal, degrade accuracy by an additional 0.5% of reading.
- For 1A (Class 2) Nominal, the input current range for Accuracy specification is 20% of the values listed in the table.

[2] For unbalanced voltage inputs where at least one crosses the 150V auto-scale threshold (for example, 120V/120V/208V system), degrade accuracy by additional 0.4%.

3: Mechanical Installation

3.1: Introduction

The Shark® 100 meter can be installed using a standard ANSI C39.1 (4" round) or an IEC 92mm DIN (square) form. In new installations, simply use existing DIN or ANSI punches. For existing panels, pull out old analog meters and replace with the Shark® meter. See Section 3.4 for Shark® 100T Installation. See Chapter 4 for wiring diagrams.

Recommended Tools for Shark® 100 Meter Installation

#2 Phillips screwdriver, small wrench and wire cutters. Shark® 100T Installation requires no tools.

Mount the meter in a dry location, which is free from dirt and corrosive substances. The meter is designed to withstand harsh environmental conditions (see environmental specifications in Chapter 2).

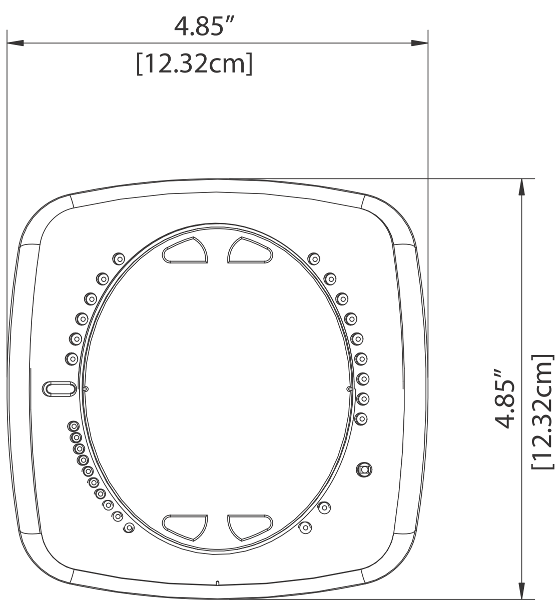


Figure 3.1: Meter Face

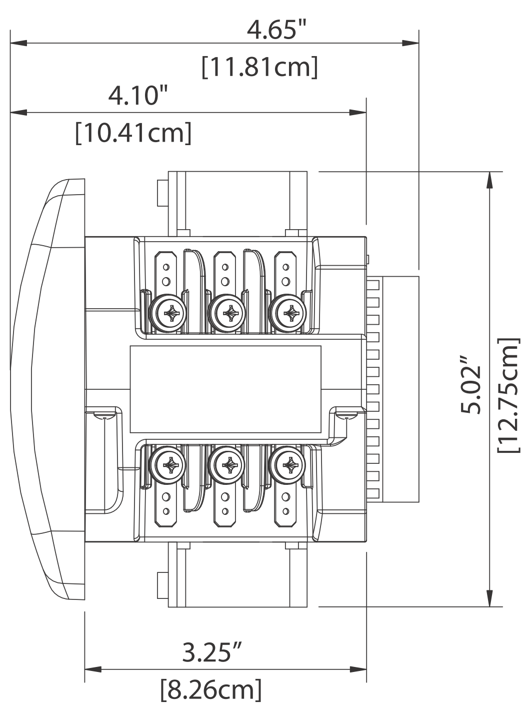


Figure 3.2: Meter Side

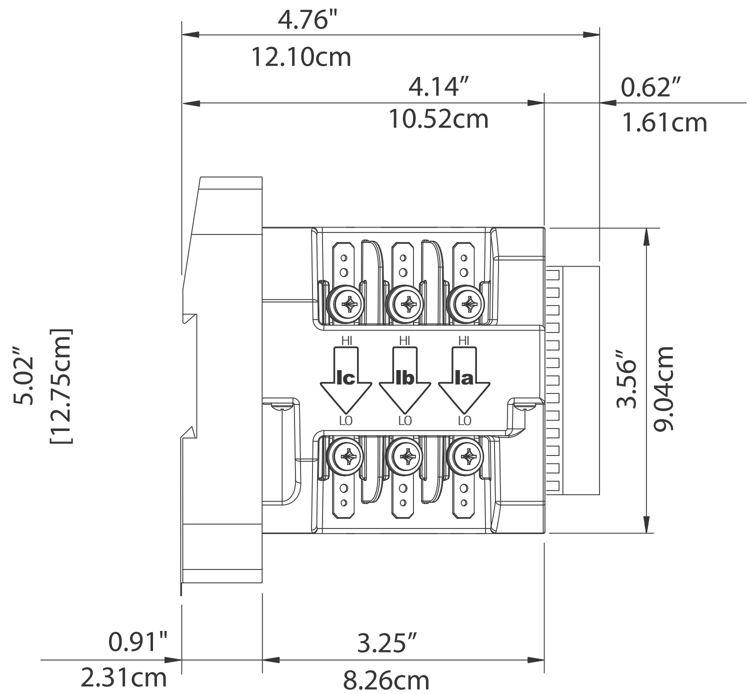


Figure 3.3: Transducer Side

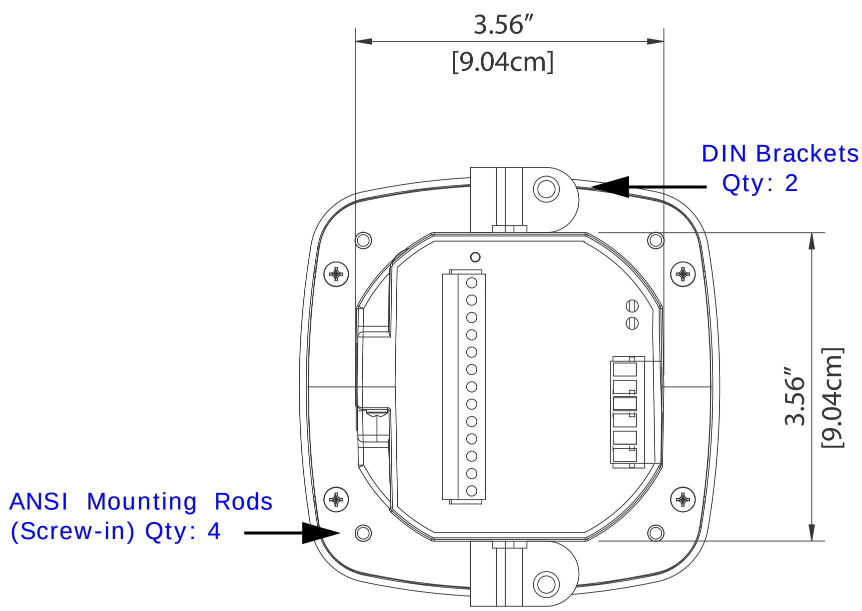


Figure 3.4: Meter Back

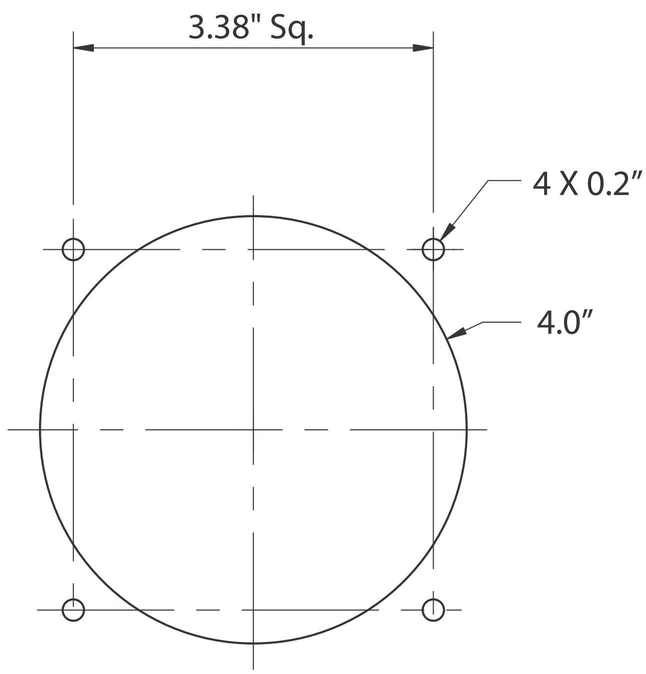


Figure 3.5: ANSI Mounting Cutout

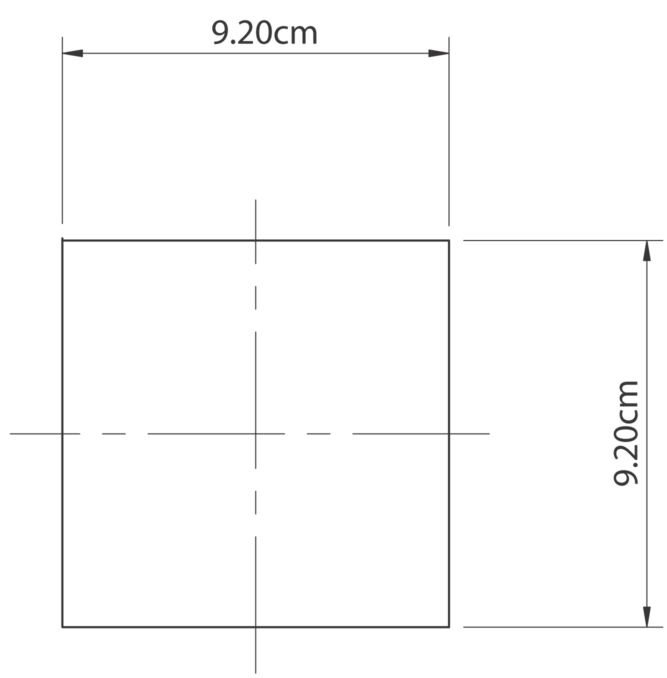
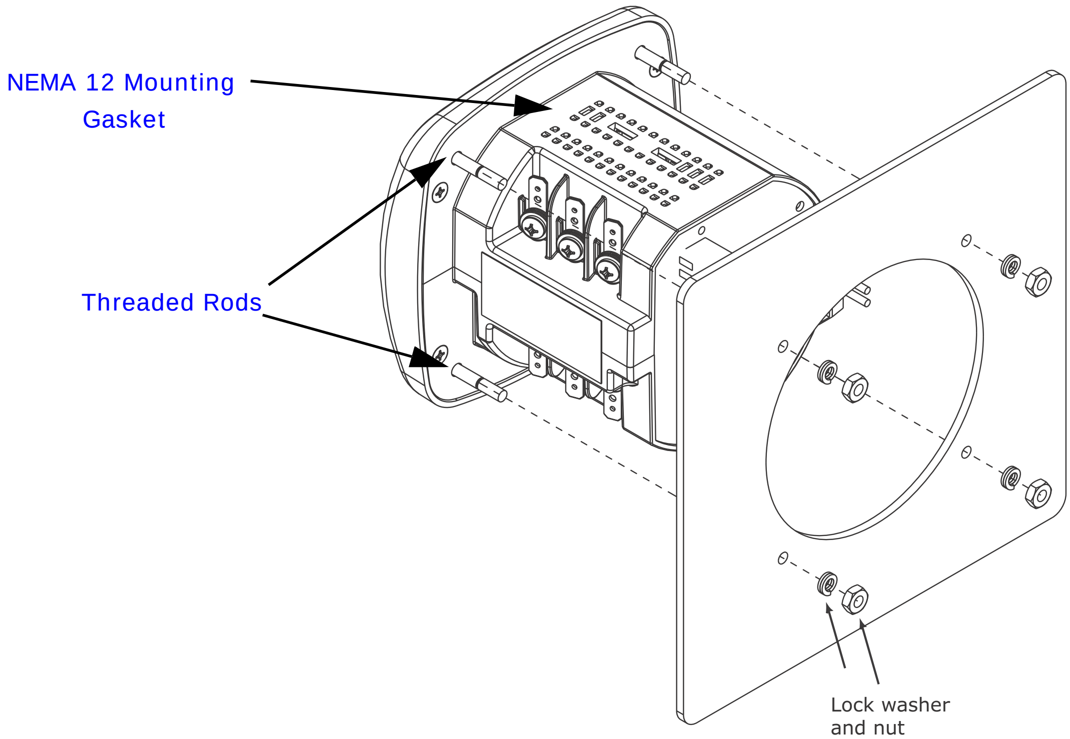
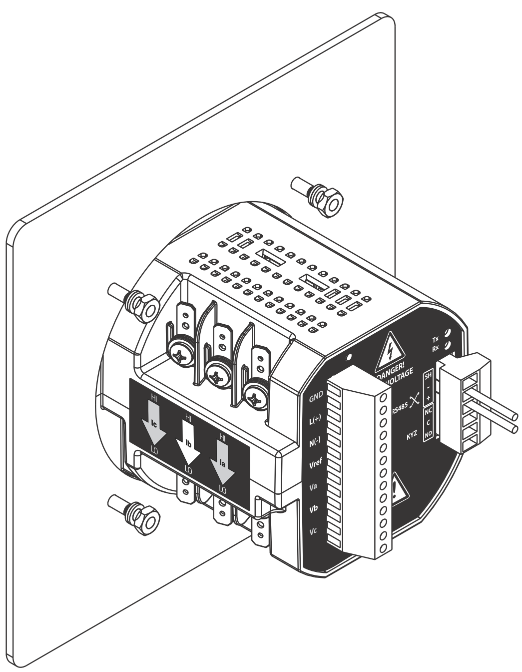


Figure 3.6: DIN Mounting Cutout

3.2: ANSI Installation Steps



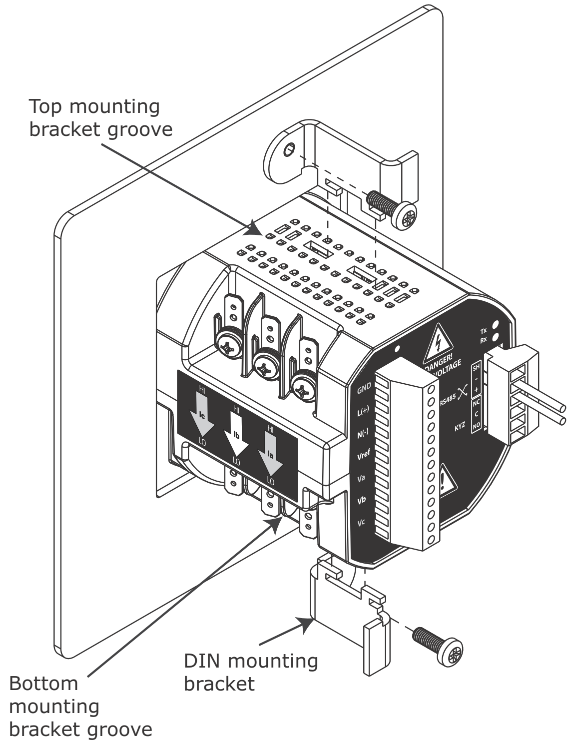


INSTALLATION STEPS:

1. Insert 4 threaded rods by hand into the back of meter. Twist until secure.
2. Slide ANSI 12 Mounting Gasket onto back of meter with rods in place.
3. Slide meter with Mounting Gasket into panel.
4. Secure from back of panel with lock washer and nut on each threaded rod. Use a small wrench to tighten. Do not overtighten: the maximum installation torque is 0.4 Newton-Meter.

Figure 3.7: ANSI Installation

3.3: DIN Installation Steps



INSTALLATION STEPS:

1. Slide meter with NEMA 12 Mounting Gasket into panel. (Remove ANSI Studs, if in place.)
2. From back of panel, slide 2 DIN Mounting Brackets into grooves in top and bottom of meter housing. Snap into place.
3. Secure meter to panel with lock washer and a #8 screw through each of the mounting brackets. Tighten with a #2 Phillips screw-driver. Do not overtighten: the maximum installation torque is 0.4 Newton-Meter.

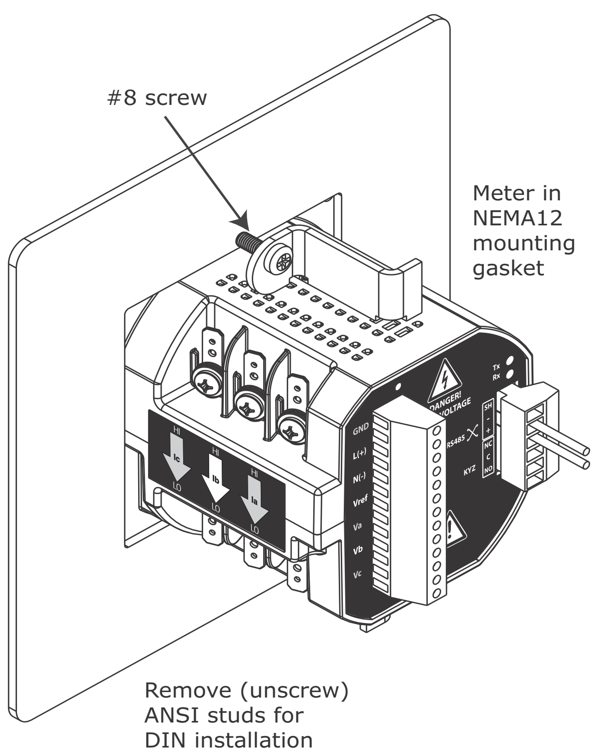


Figure 3.8: DIN Installation

3.4: Shark® 100T Transducer Installation

The Shark® 100T Transducer model is installed using DIN Rail Mounting.

Specs for DIN Rail Mounting

International Standards DIN 46277-3

DIN Rail (Slotted) Dimensions: 7.55mm x 35mm

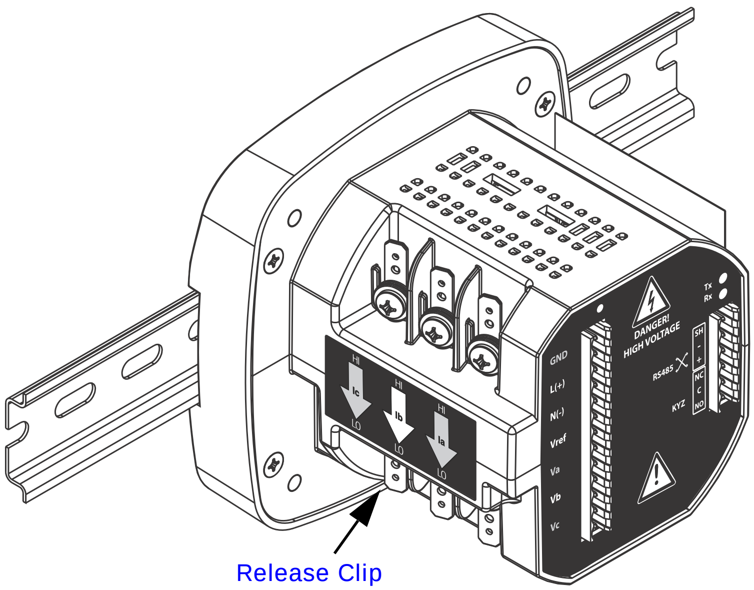


Figure 3.9: DIN Rail Mounting

DIN RAIL INSTALLATION STEPS:

1. Slide top groove of meter onto the DIN Rail.

2. Press gently until the meter clicks into place.

NOTE: If mounting with the DIN Rail provided, use the Black Rubber Stoppers (also provided). See Figure 3.10.

TO REMOVE METER FROM DIN RAIL:

Pull down on Release clip to detach the unit from the DIN rail.

NOTE ON DIN RAILS:

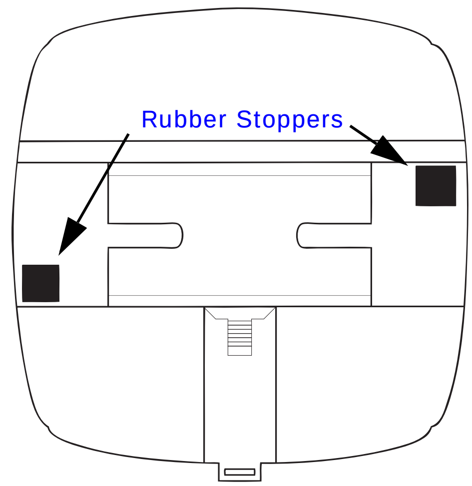


Figure 3.10: DIN Rail Detail

DIN rails are commonly used as a mounting channel for most terminal blocks, control devices, circuit protection devices and PLCs. DIN Rails are made of electrolytically plated cold rolled steel but are also available in aluminum, PVC, stainless steel and copper.

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4: Electrical Installation

4.1: Considerations When Installing Meters

Installation of the Shark® 100 meter must be performed only by qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing is recommended.

During normal operation of the Shark® 100 meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits.

All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.

Do not use the meter or any I/O Output Device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection.

Do not use the meter for applications where failure of the meter may cause harm or death.

Do not use the meter for any application where there may be a risk of fire.

All meter terminals should be inaccessible after installation.

Do not apply more than the maximum voltage the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages.

Do not HIPOT/Dielectric test any Outputs, Inputs or Communications terminals.

EIG recommends the use of Shorting Blocks and Fuses for voltage leads and power supply to prevent hazardous voltage conditions or damage to CTs, if the meter needs to be removed from service. CT grounding is optional.

IMPORTANT!

- IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.
- THERE IS NO REQUIRED PREVENTIVE MAINTENANCE OR INSPECTION NECESSARY FOR SAFETY. HOWEVER, ANY REPAIR OR MAINTENANCE SHOULD BE PERFORMED BY THE FACTORY.

DISCONNECT DEVICE: The following part is considered the equipment disconnect device. A SWITCH OR CIRCUIT-BREAKER SHALL BE INCLUDED IN THE END-USE EQUIPMENT OR BUILDING INSTALLATION. THE SWITCH SHALL BE IN CLOSE PROXIMITY TO THE EQUIPMENT AND WITHIN EASY REACH OF THE OPERATOR. THE SWITCH SHALL BE MARKED AS THE DISCONNECTING DEVICE FOR THE EQUIPMENT.

4.2: CT Leads Terminated to Meter

The Shark® 100 meter is designed to have current inputs wired in one of three ways. Figure 4.1 shows the most typical connection where CT Leads are terminated to the meter at the current gills. This connection uses nickel-plated brass studs (current gills) with screws at each end. This connection allows the CT wires to be terminated using either an “O” or a “U” lug. Tighten the screws with a #2 Phillips screwdriver. The maximum installation torque is 1 Newton-Meter.

Other current connections are shown in Figures 4.2 and 4.3. Voltage and RS485/KYZ connections are shown in Figure 4.4.

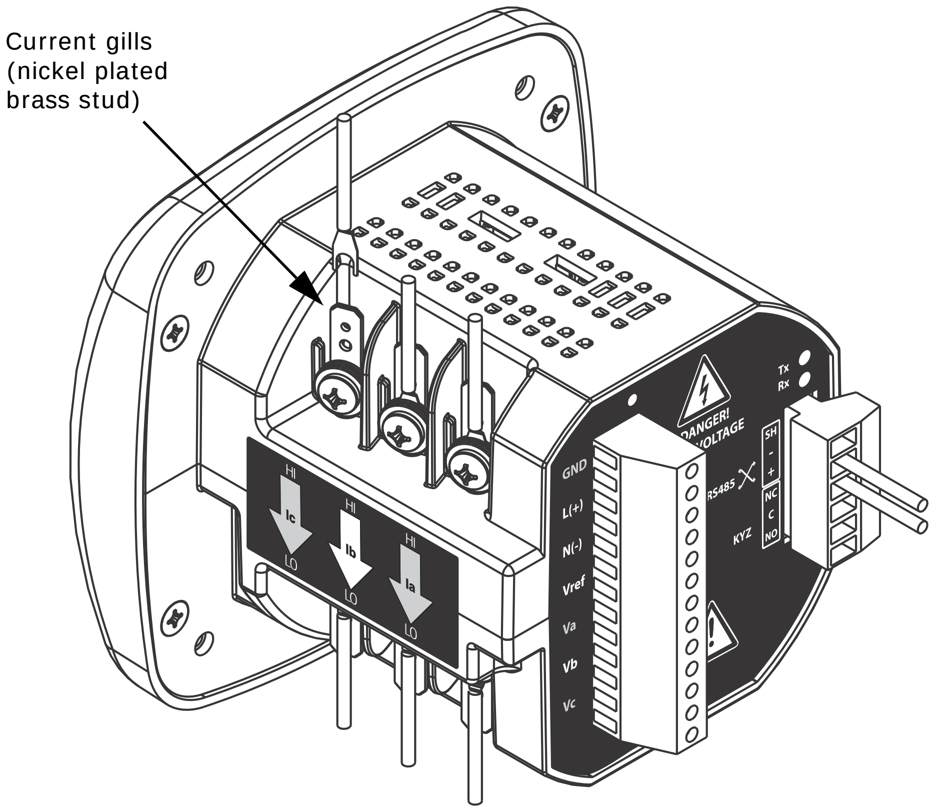


Figure 4.1: CT Leads terminated to Meter, #8 Screw for Lug Connection

Wiring diagrams are shown in Section 4.8 of this chapter.

Communication connections are detailed in Chapter 5.

4.3: CT Leads Pass Through (No Meter Termination)

The second method allows the CT wires to pass through the CT inputs without terminating at the meter. In this case, remove the current gills and place the CT wire directly through the CT opening. The opening accommodates up to 0.177” / 4.5mm maximum diameter CT wire.

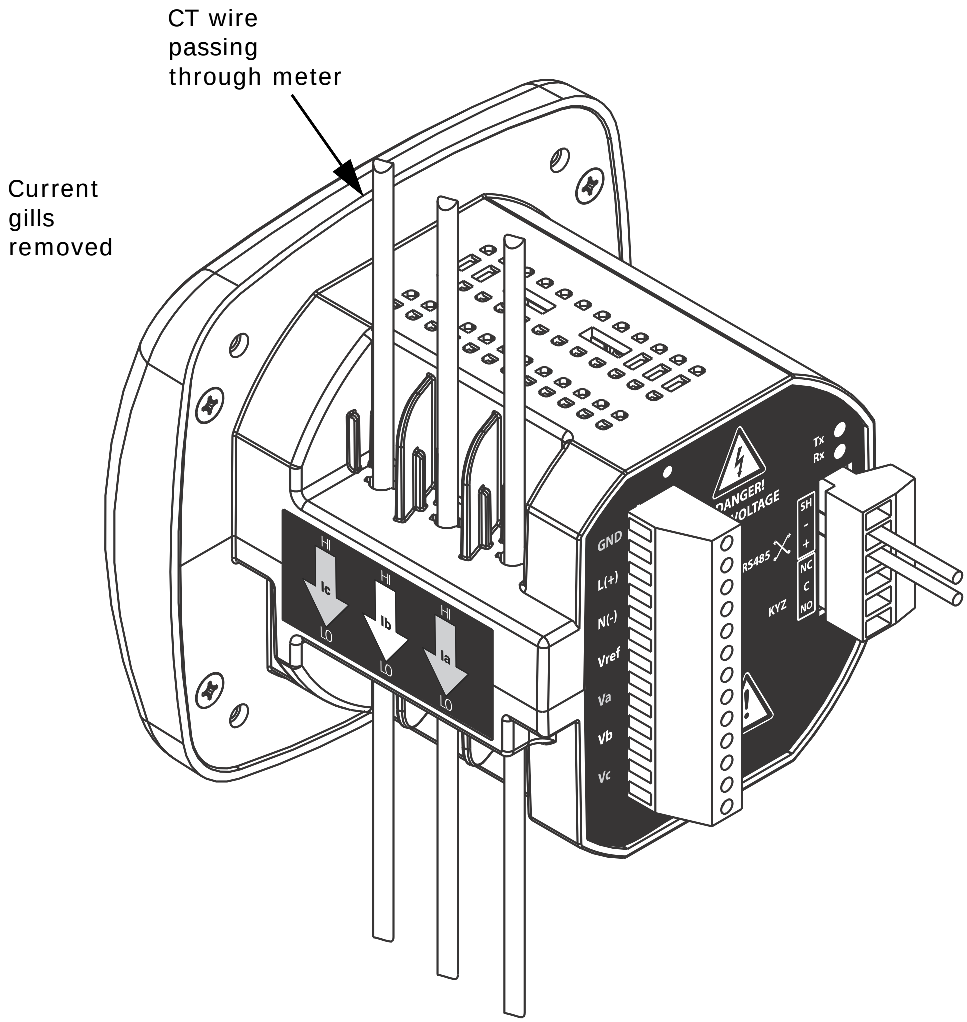


Figure 4.2: Pass Through Wire Electrical Connection

4.4: Quick Connect Crimp-on Terminations

For quick termination or for portable applications, 0.25” quick connect crimp-on connectors can also be used.

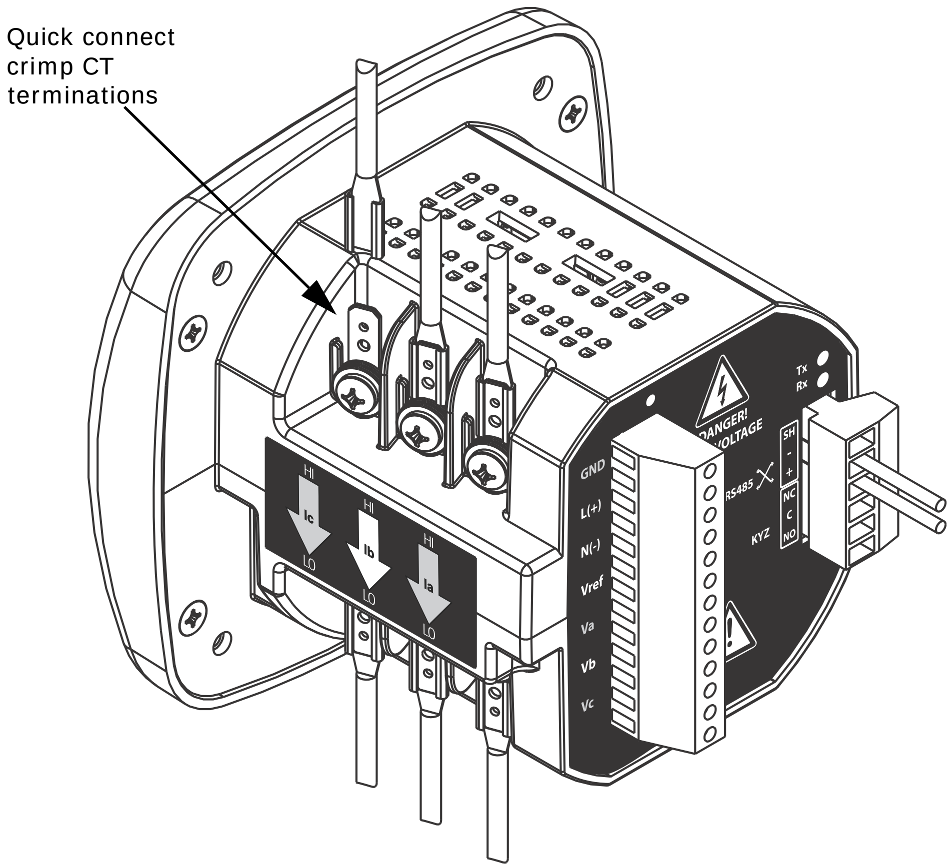


Figure 4.3: Quick Connect Electrical Connection

4.5: Voltage and Power Supply Connections

Voltage inputs are connected to the back of the unit via optional wire connectors. The connectors accommodate AWG# 12-26/(0.129 - 3.31)mm^2.

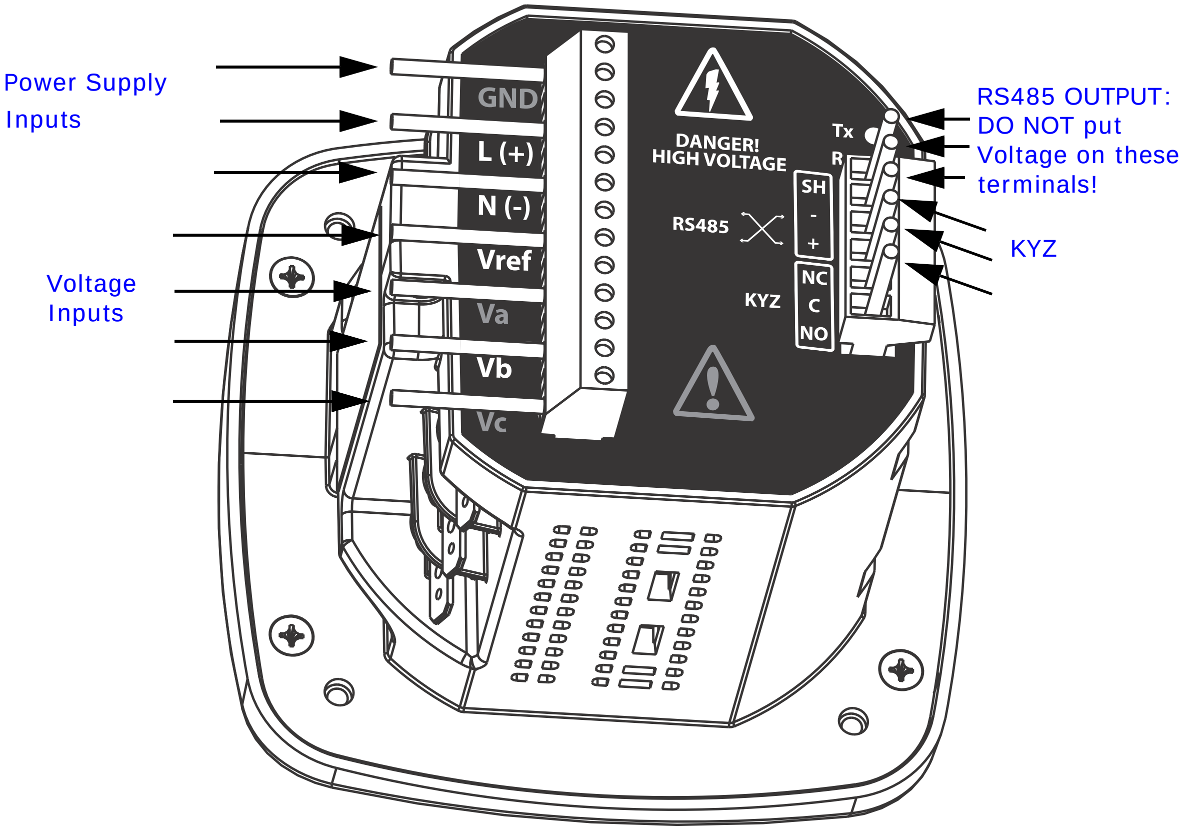


Figure 4.4: Meter Connection

4.6: Ground Connections

The meter's Ground terminals should be connected directly to the installation's protective earth ground. Use AWG# 12/2.5 mm^2 wire for this connection.

4.7: Voltage Fuses

EIG recommends the use of fuses on each of the sense Voltages and on the control power, even though the wiring diagrams in this chapter do not show them.

- Use a 0.1 Amp fuse on each Voltage input.
- Use a 3 Amp Slow Blow fuse on the power supply.
  EIG offers the EI-CP Panel meter protective fuse kit, which can be ordered from

EIG's webstore: www.electroind.com/store. Select Fuse Kits from the list on the left side of the webpage.

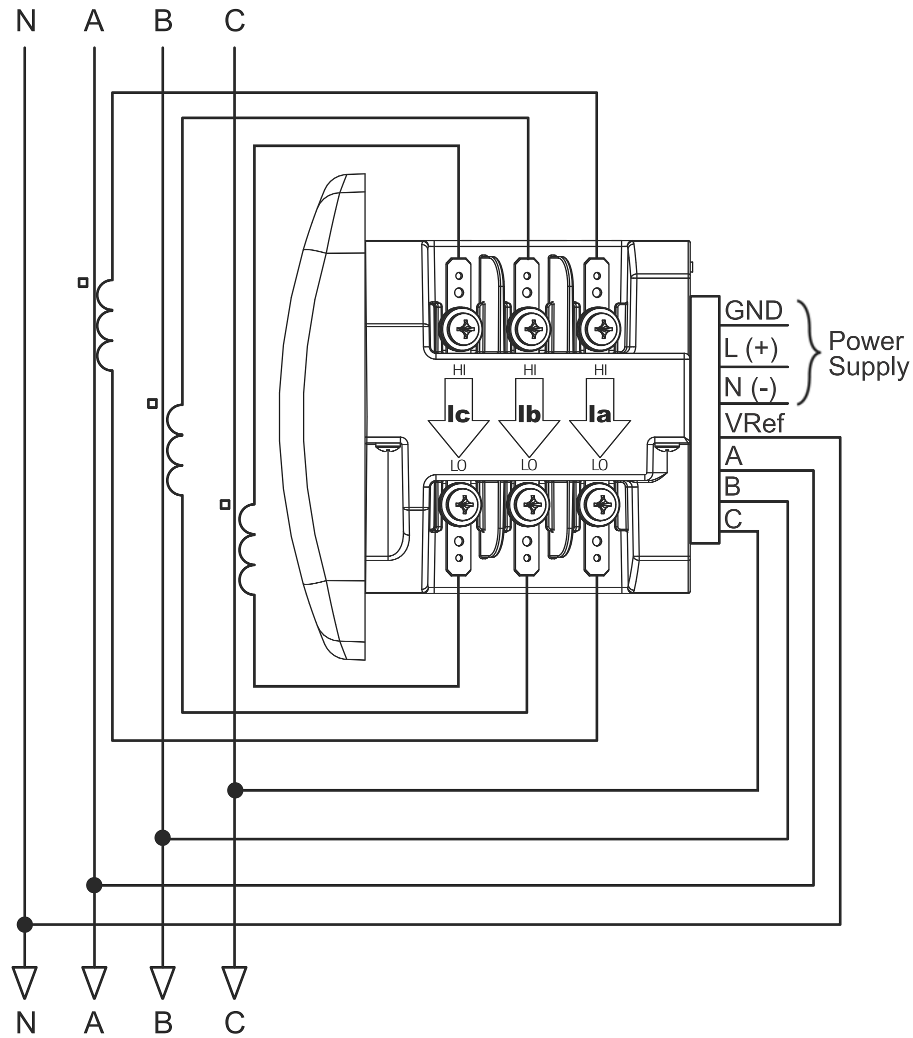
4.8: Electrical Connection Diagrams

The following pages contain electrical connection diagrams for the Shark® 100 meter. Choose the diagram that best suits your application. Be sure to maintain the CT polarity when wiring.

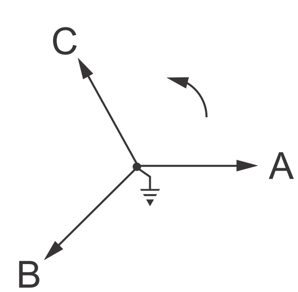
The diagrams are presented in the following order:

1. Three Phase, Four-Wire System Wye with Direct Voltage, 3 Element
   a. Example of Dual-Phase Hookup
   b. Example of Single Phase Hookup
2. Three Phase, Four-Wire System Wye with Direct Voltage, 2.5 Element
3. Three-Phase, Four-Wire Wye with PTs, 3 Element
4. Three-Phase, Four-Wire Wye with PTs, 2.5 Element
5. Three-Phase, Three-Wire Delta with Direct Voltage
6. Three-Phase, Three-Wire Delta with 2 PTs
7. Three-Phase, Three-Wire Delta with 3 PTs
8. Current Only Measurement (Three Phase)
9. Current Only Measurement (Dual Phase)
10. Current Only Measurement (Single Phase)

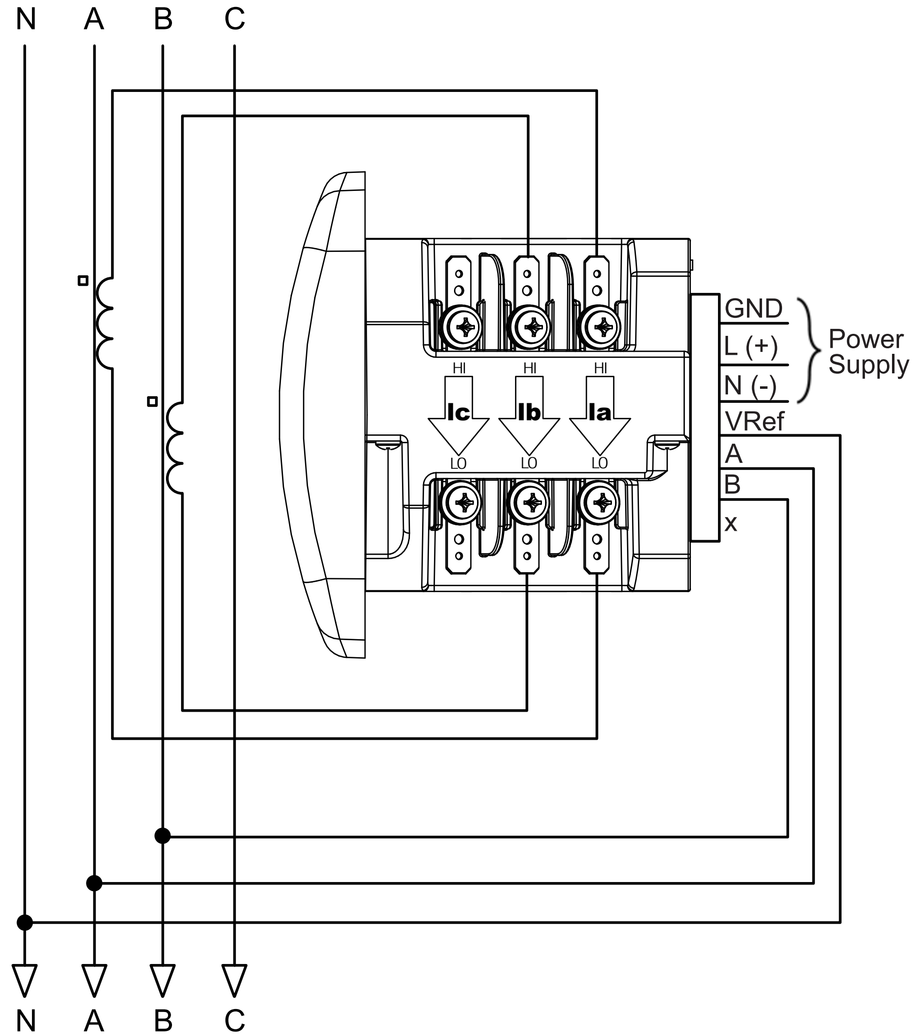
1. Service: WYE, 4-Wire with No PTs, 3 CTs



Select: “ 3 EL WYE ” (3 Element Wye) from the Shark® meter’s Front Panel Display. (See Chapter 6.)

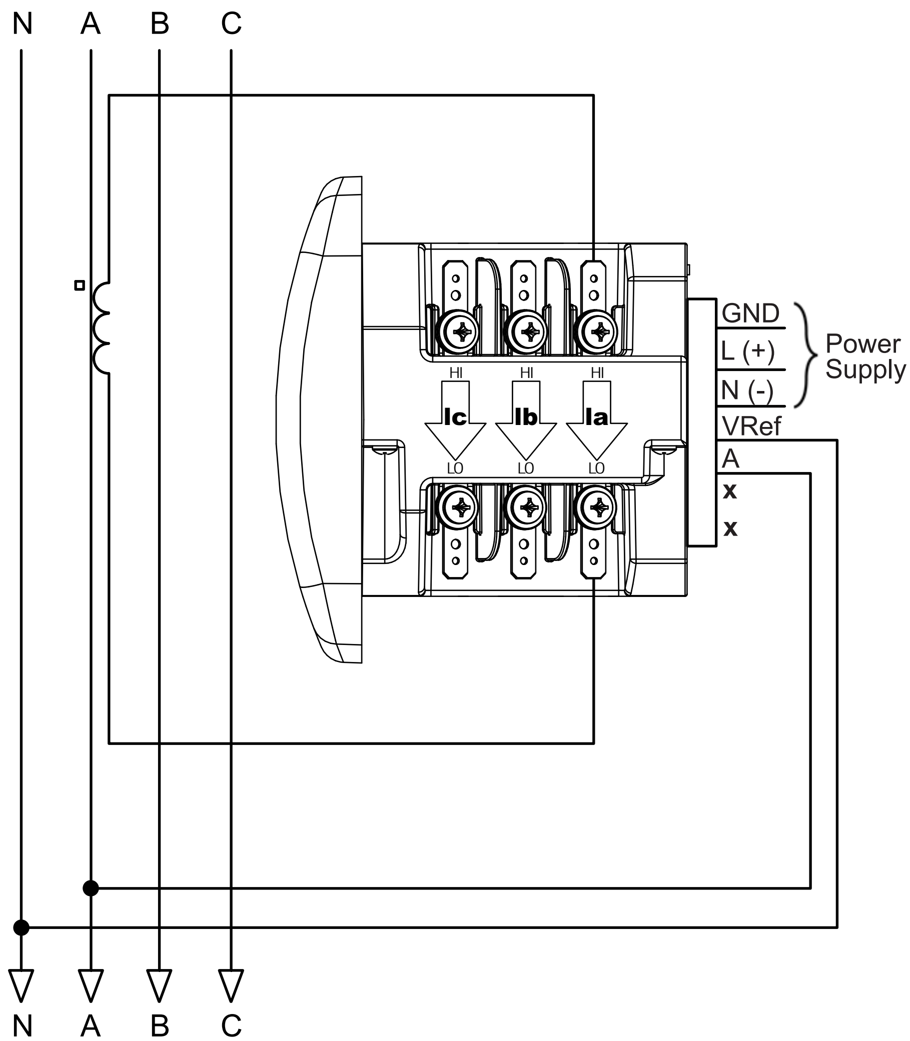


1a. Example of Dual Phase Hookup



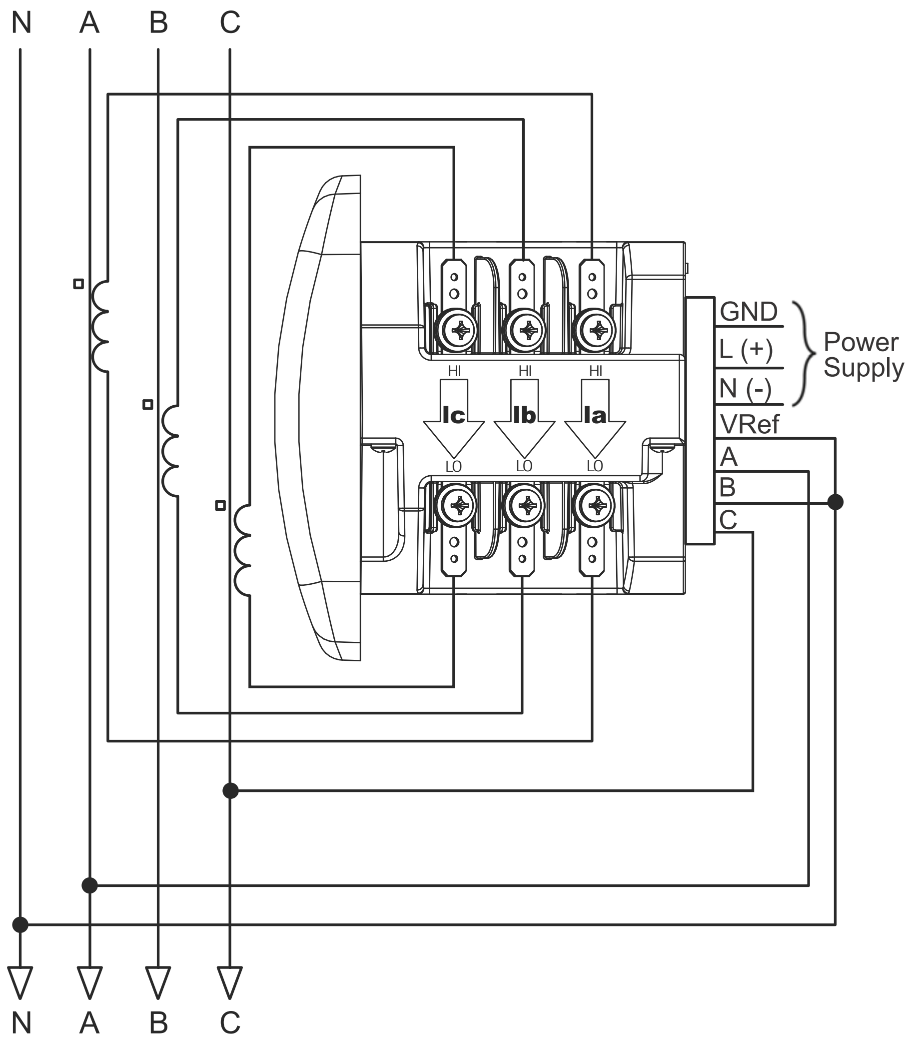
Select: " 3 EL WYE " (3 Element Wye) from the Shark® meter's Front Panel Display. (See Chapter 6.)

1b. Example of Single Phase Hookup

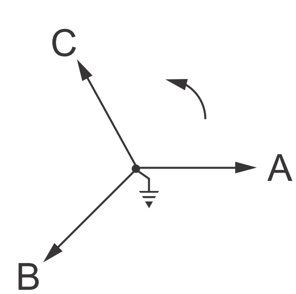


Select: " 3 EL WYE " (3 Element Wye) from the Shark® meter's Front Panel Display. (See Chapter 6.)

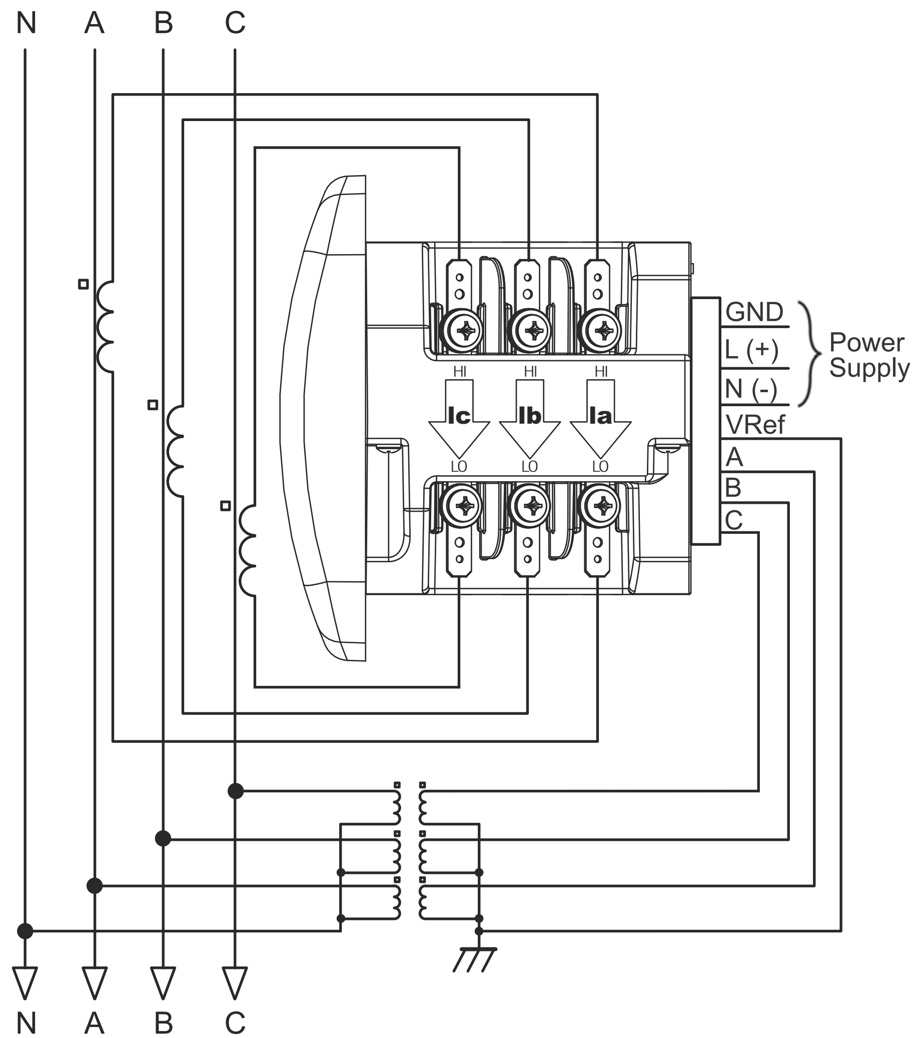
2. Service: 2.5 Element WYE, 4-Wire with No PTs, 3 CTs



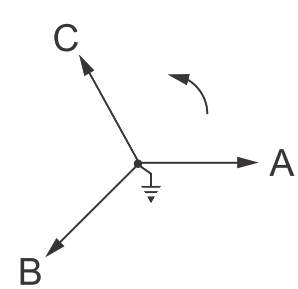
Select: “2.5 EL WYE” (2.5 Element Wye) from the Shark® meter’s Front Panel Display. (See Chapter 6.)



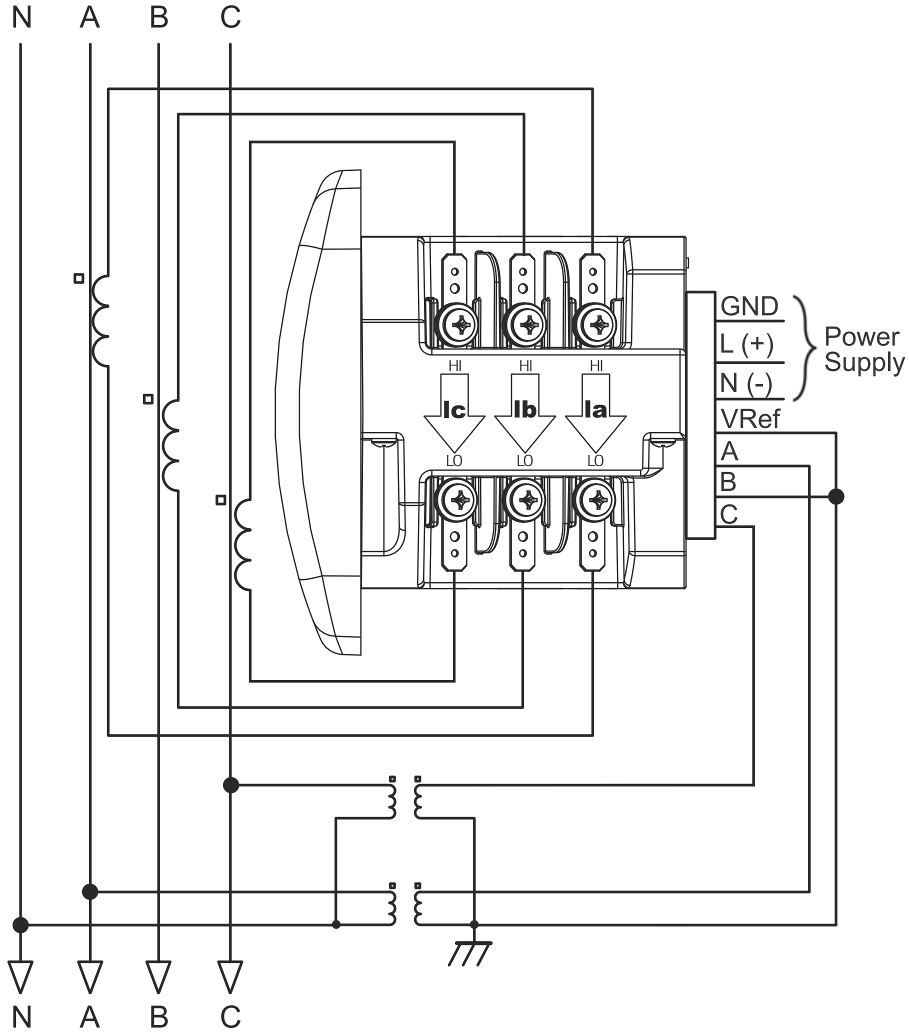
3. Service: WYE, 4-Wire with 3 PTs, 3 CTs



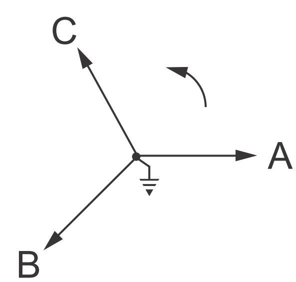
Select: “3 EL WYE” (3 Element Wye) from the Shark® meter’s Front Panel Display. (See Chapter 6.)



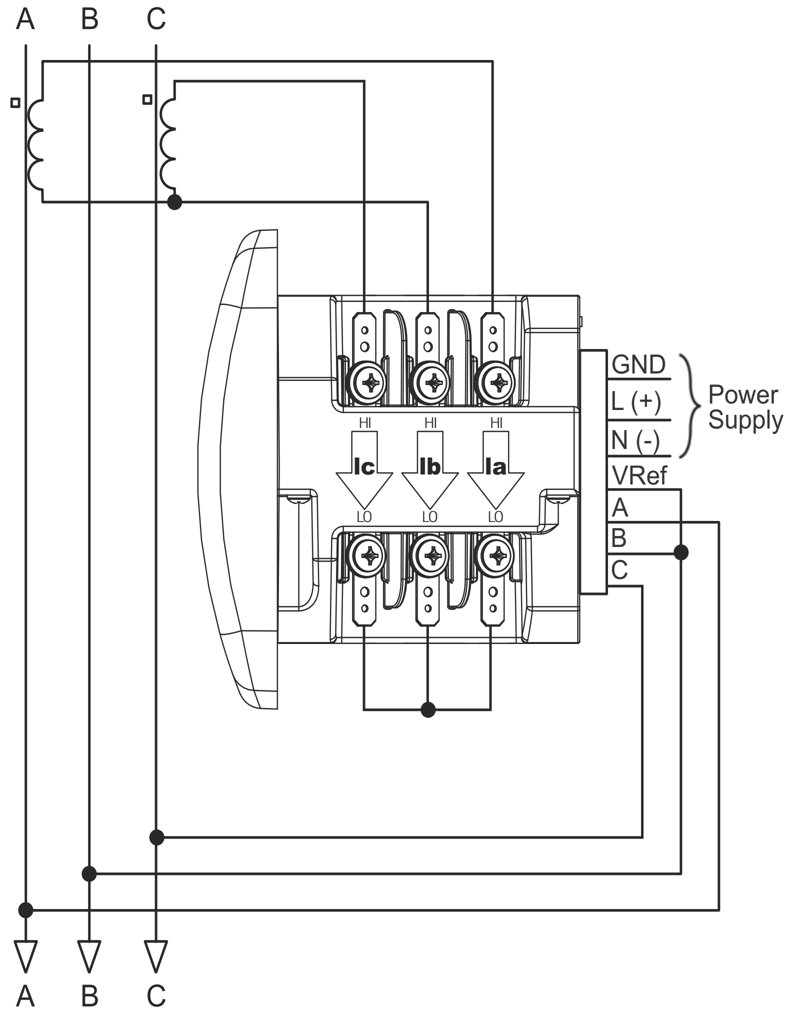
4. Service: 2.5 Element WYE, 4-Wire with 2 PTs, 3 CTs



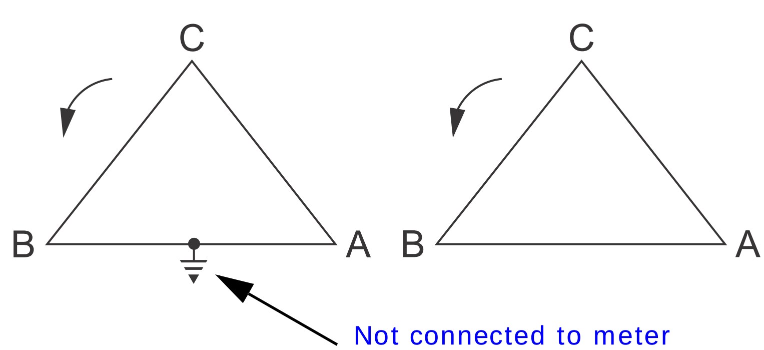
Select: "2.5 EL WYE" (2.5 Element Wye) from the Shark® meter's Front Panel Display. (See Chapter 6.)



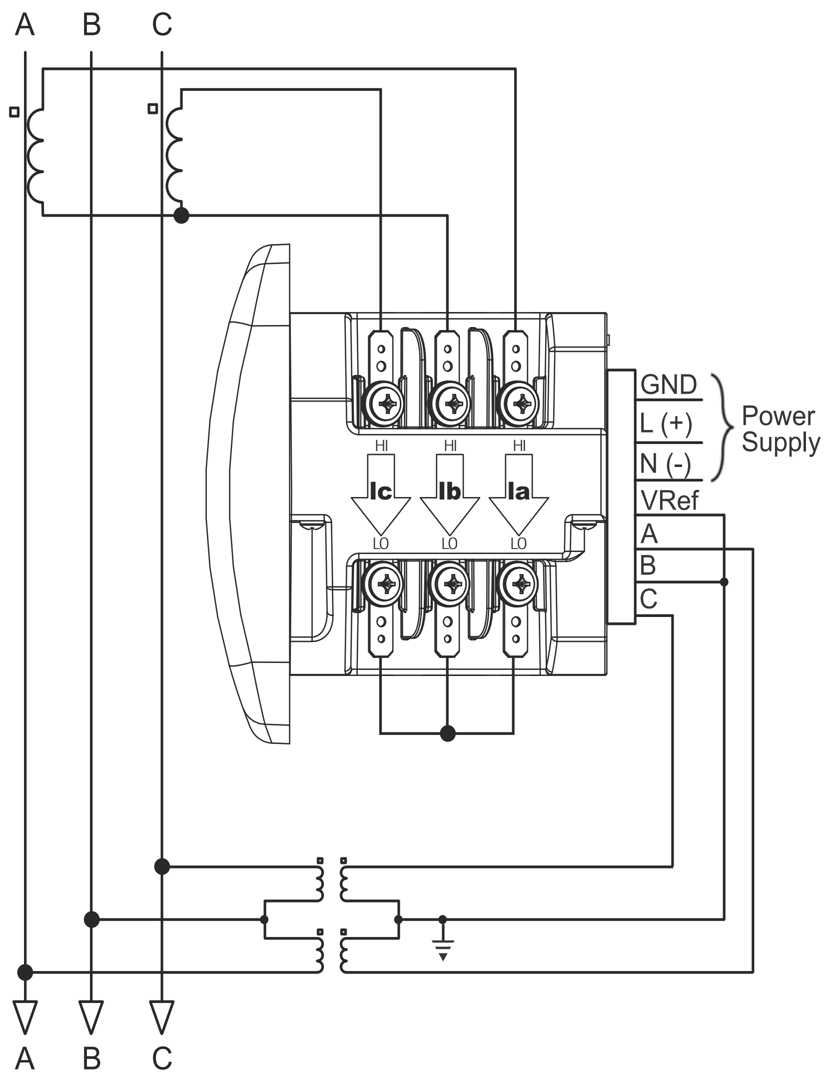
5. Service: Delta, 3-Wire with No PTs, 2 CTs



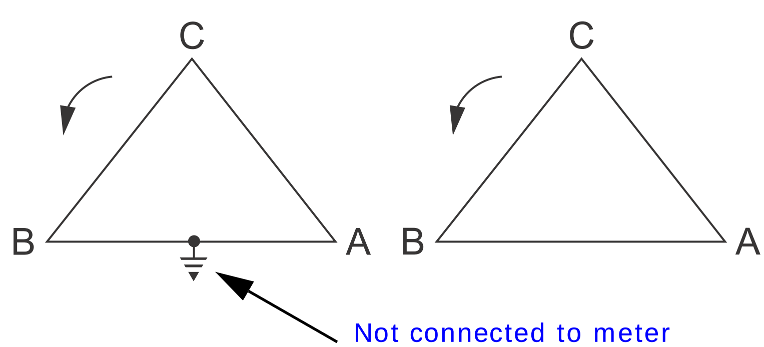
Select: "2 CT DEL" (2 CT Delta) from the Shark® meter's Front Panel Display. (See Chapter 6.)



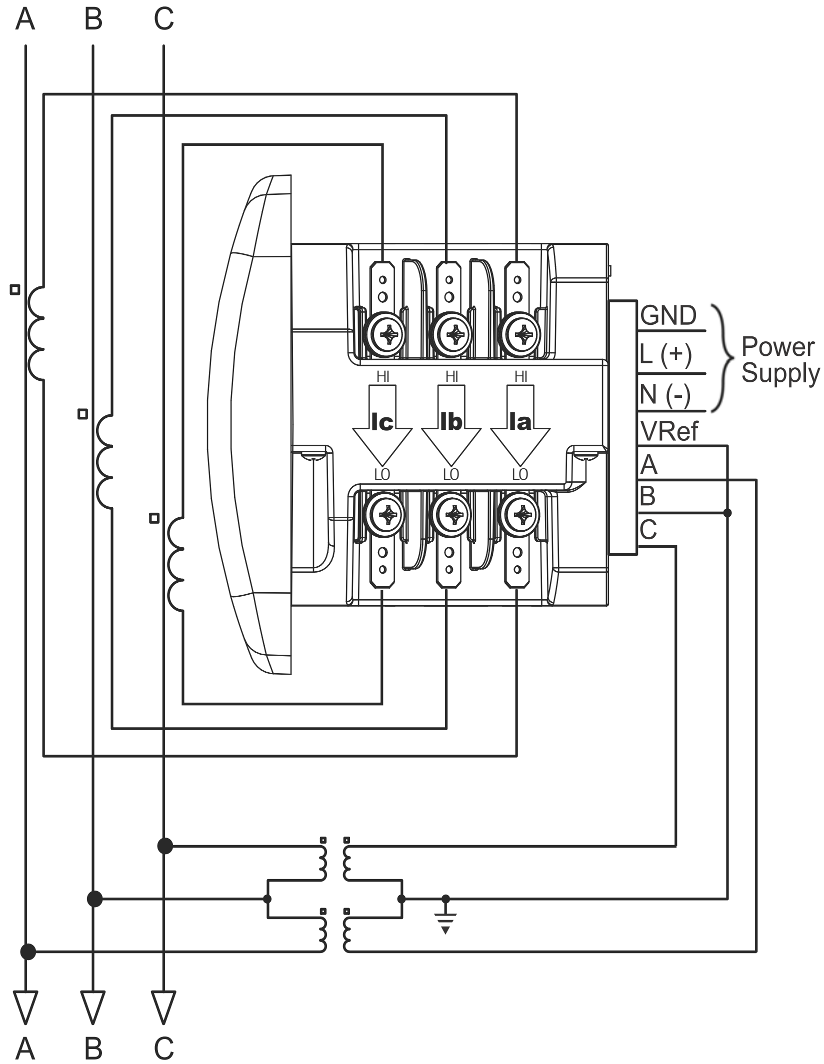
6. Service: Delta, 3-Wire with 2 PTs, 2 CTs



Select: “2 CT DEL” (2 CT Delta) from the Shark® meter’s Front Panel Display. (See Chapter 6.)

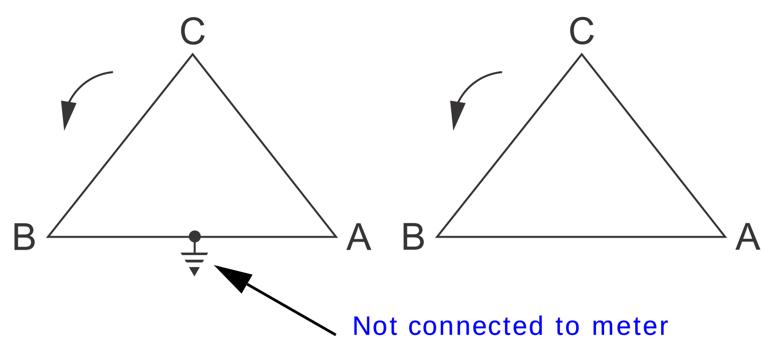


7. Service: Delta, 3-Wire with 2 PTs, 3 CTs

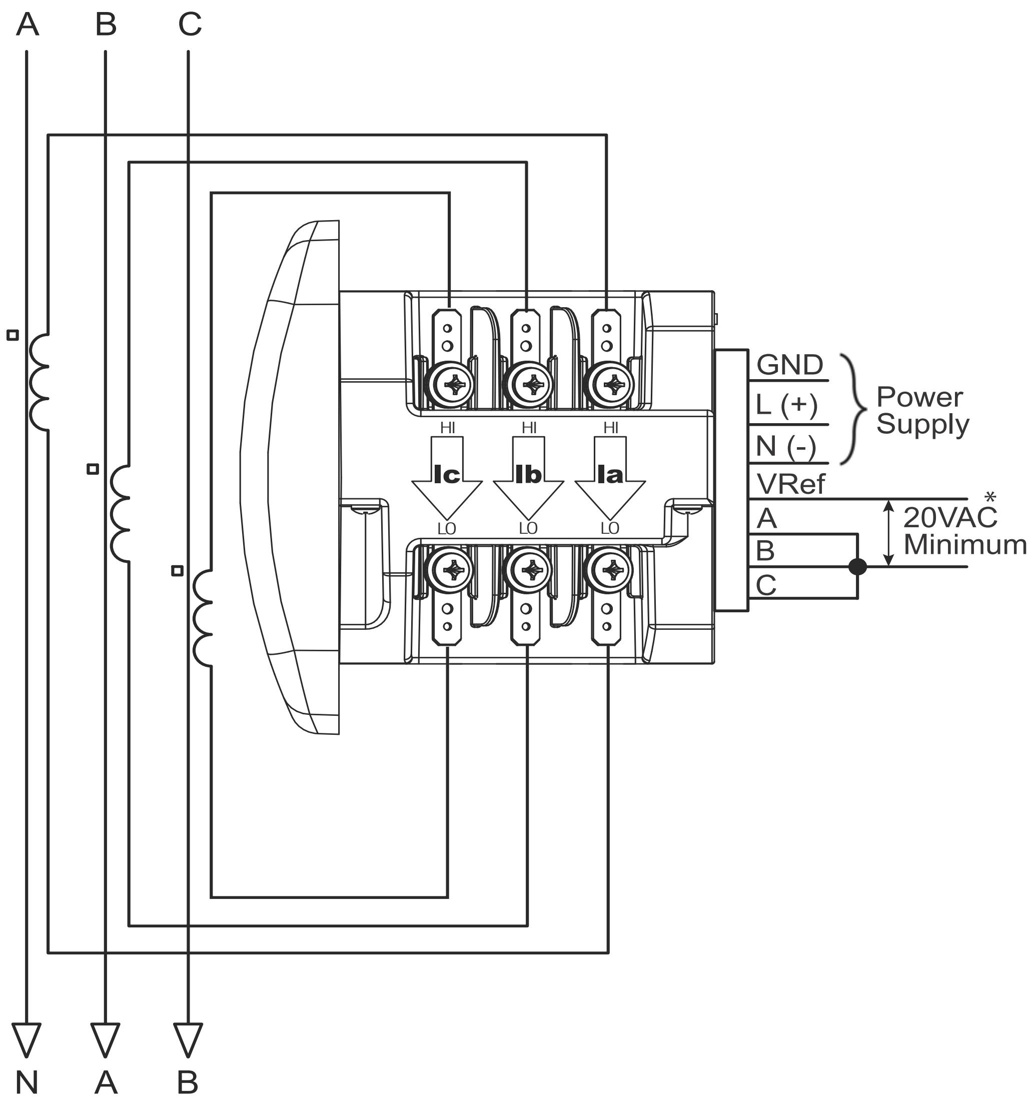


Select: “2 CT DEL” (2 CT Delta) from the Shark® meter’s Front Panel Display. (See Chapter 6.)

NOTE: The third CT for hookup is optional, and is used only for Current measurement.



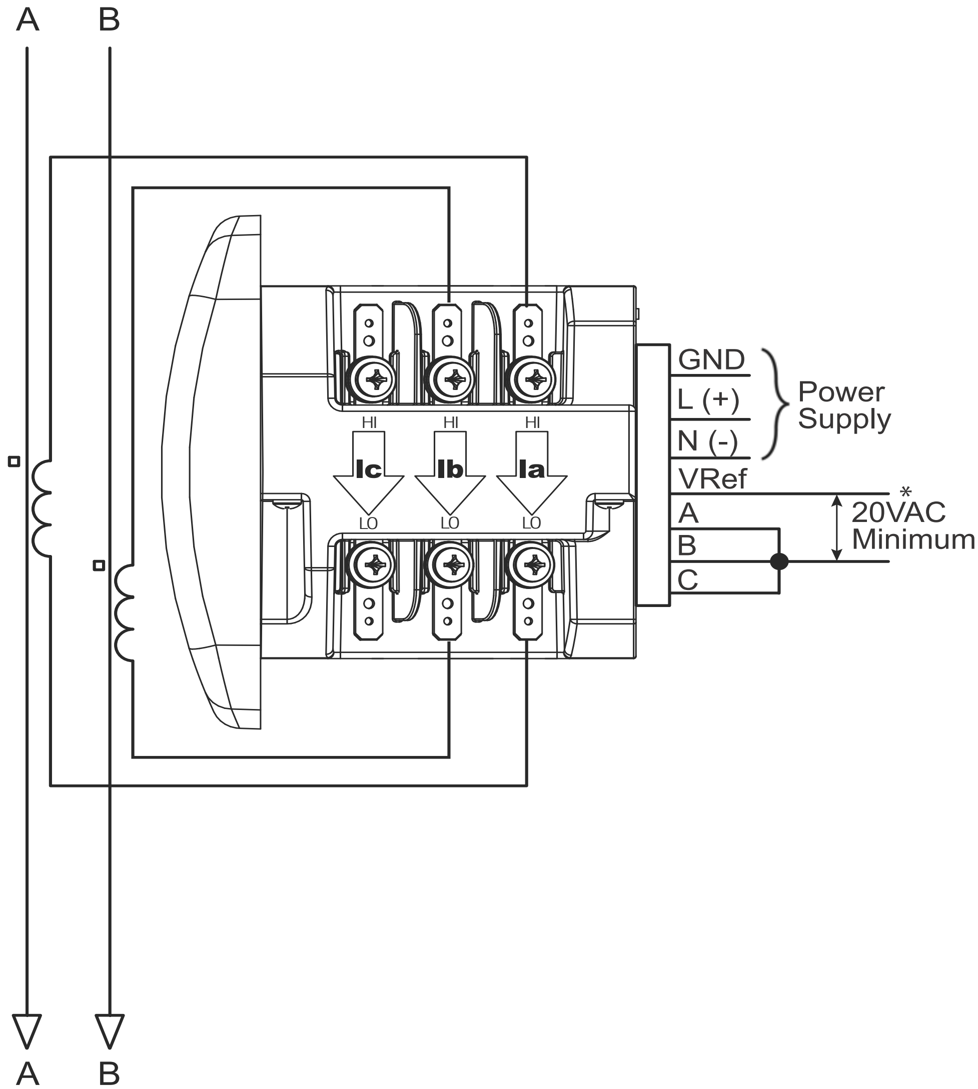
8. Service: Current Only Measurement (Three Phase)



Select: "3 EL WYE" (3 Element Wye) from the Shark® meter's Front Panel Display. (See Chapter 6.)

***** This connection is not required, but is recommended for improved accuracy.

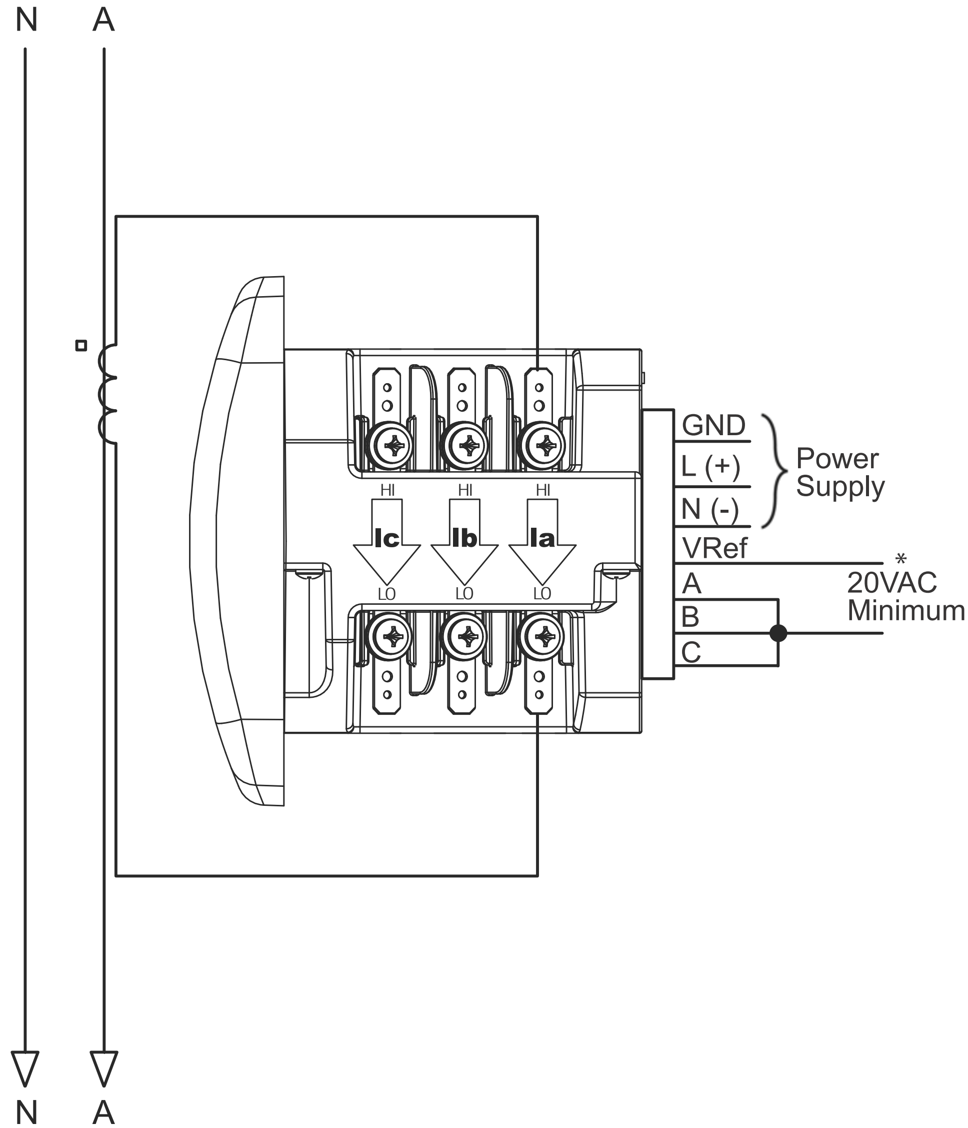
9. Service: Current Only Measurement (Dual Phase)



Select: “3 EL WYE” (3 Element Wye) from the Shark® meter’s Front Panel Display. (See Chapter 6.)

* This connection is not required, but is recommended for improved accuracy.

10. Service: Current Only Measurement (Single Phase)



Select: “3 EL WYE” (3 Element Wye) from the Shark® meter’s Front Panel Display. (See Chapter 6.)

* This connection is not required, but is recommended for improved accuracy.

NOTE: The diagram shows a connection to Phase A, but you can also connect to Phase B or Phase C.

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5: Communication Installation

5.1: Shark® 100 Meter Communication

The Shark® 100 meter provides two independent Communication ports. The first port, Com 1, is an optical IrDA port. The second port, Com 2, provides RS485 communication speaking Modbus ASCII, Modbus RTU and DNP 3.0 (V-3 and V-4) protocols.

5.1.1: IrDA Port (Com 1)

The Shark® 100 meter's Com 1 IrDA port is on the face of the meter. The IrDA port allows the unit to be set up and programmed without the need for a communication cable. Just point at the meter with an IrDA-enabled PC to configure it.

Figure 5.1: IrDA Communication

Com 1 (IrDA port) settings

Address: 1

Baud Rate: 57.6k

Protocol: Modbus ASCII

Additional settings are configured using Communicator EXT software. Refer to the *Communicator EXT User Manual* for instructions.
EIG recommends the CAB6490 USB to IrDA adapter, which can be ordered from the EIG webstore: www.electroind.com/store. Select Cables & Accessories from the left side of the webpage.

5.1.2: RS485/KYZ Output Com 2 (485P Option)

The 485P Option provides a combination RS485 and KYZ Pulse Output for pulsing energy values. The RS485/KYZ Combo is located on the terminal section of the meter.

See Section 2.2 for the KYZ Output specifications, and Section 6.3.1 for pulse constants.

The Shark® 100 meter's RS485 can be programmed with the buttons on the face of the meter or by using Communicator EXT 3.0 software.

Standard RS485 Port Settings

Address: 001 to 247

Baud Rate: 9600, 19200, 38400 or 57600

Protocol: Modbus RTU, Modbus ASCII, DNP 3.0 (V-3 and V-4 Only)

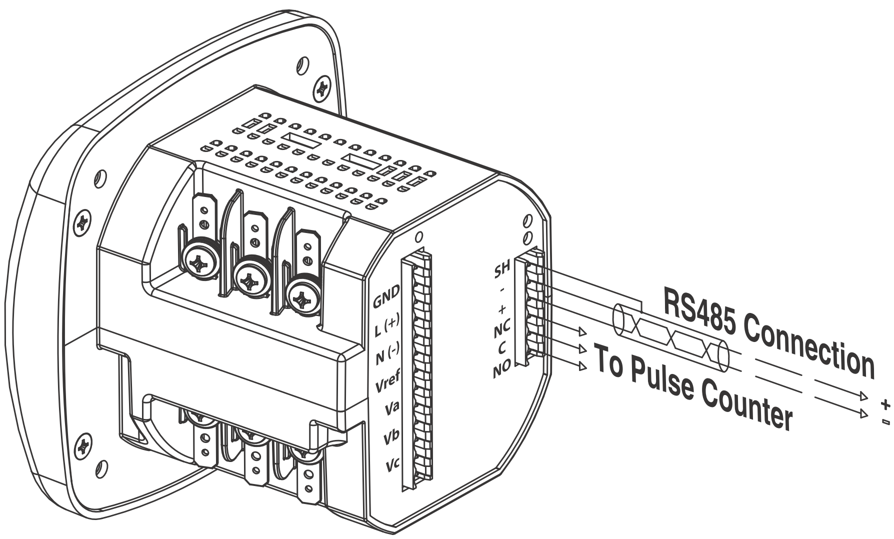


Figure 5.2: 485P Option with RS485 Communication

RS485 allows you to connect one or multiple Shark® 100 meters to a PC or other device, at either a local or remote site. All RS485 connections are viable for up to 4000 feet (1219.20 meters).

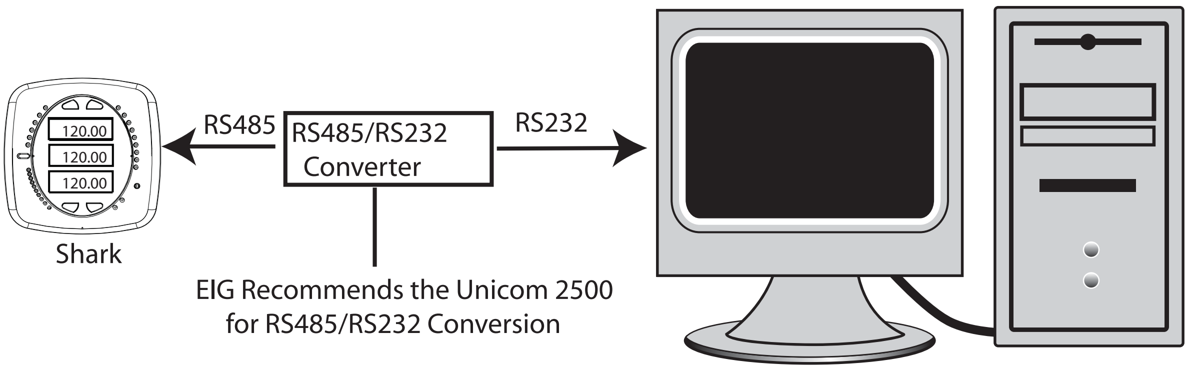


Figure 5.3: Shark® 100 Connected to PC via RS485

As shown in Figure 5.3, to connect a Shark® 100 to a PC, you need to use an RS485 to RS232 converter, such as EIG's Unicom 2500. See Section 5.1.2.1 for information on using the Unicom 2500 with the Shark® 100. Figure 5.4 shows the detail of a 2-wire RS485 connection.

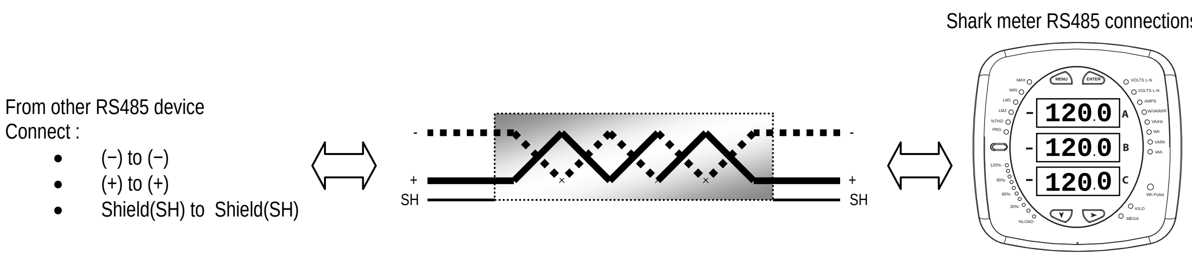


Figure 5.4: 2-wire RS485 Connection

NOTES For All RS485 Connections:

- Use a shielded twisted pair cable 22 AWG (0.33 mm2) or larger, grounding the shield at one end only.
- Establish point-to-point configurations for each device on a RS485 bus: connect (+) terminals to (+) terminals; connect (-) terminals to (-) terminals.
- You may connect up to 31 meters on a single bus using RS485. Before assembling the bus, each meter must be assigned a unique address: refer to Chapter 5 of the *Communicator EXT User Manual* for instructions.

- Protect cables from sources of electrical noise.
- Avoid both “Star” and “Tee” connections (see Figure 5.6).
- No more than two cables should be connected at any one point on an RS485 network, whether the connections are for devices, converters, or terminal strips.
- Include all segments when calculating the total cable length of a network. If you are not using an RS485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219.20 meters).
- Connect shield to RS485 Master and individual devices as shown in Figure 5.5. You may also connect the shield to earth-ground at one point.
- Termination Resistors (RT) may be needed on both ends of longer length transmission lines. However, since the meter has some level of termination internally, Termination Resistors may not be needed. When they are used, the value of the Termination Resistors is determined by the electrical parameters of the cable.

Figure 5.5 shows a representation of an RS485 Daisy Chain connection. Refer to Section 5.1.2.1 for details on RS485 connection for the Unicom 2500.

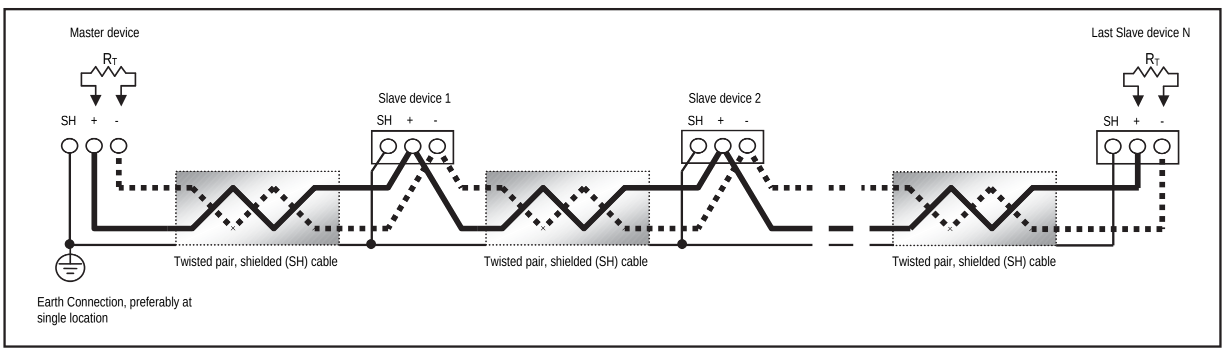


Figure 5.5: RS485 Daisy Chain Connection

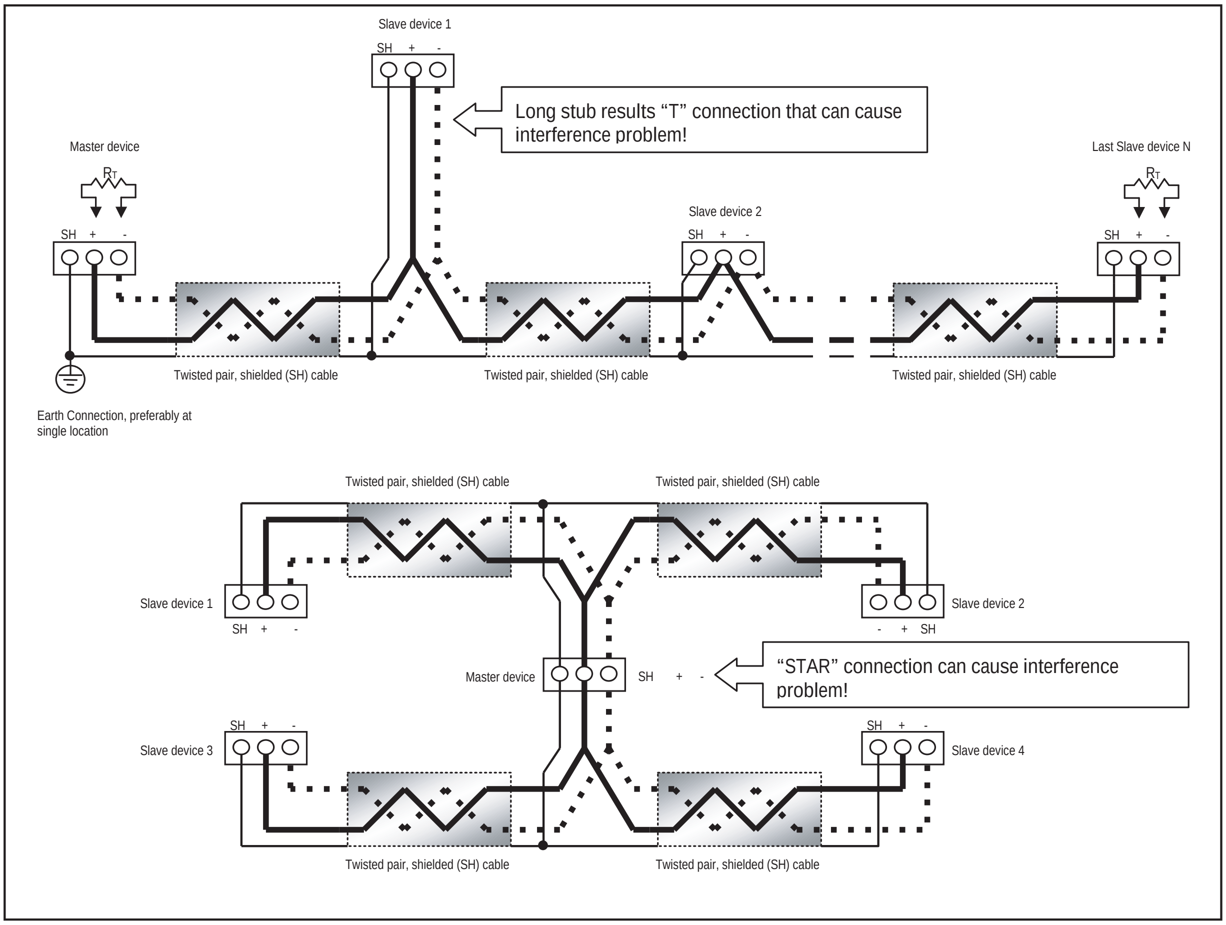


Figure 5.6: Incorrect "T" and "Star" Topologies

5.1.2.1: Using the Unicom 2500

The Unicom 2500 provides RS485/RS232 conversion. In doing so it allows a Shark® 100 with the RS485 option to communicate with a PC. See the *Unicom 2500 Installation and Operation Manual* for additional information. You can order the Unicom 2500 from EIG's webstore: www.electroind.com/store. Select Communication Products from the left side of the webpage.

Figure 5.7 illustrates the Unicom 2500 connections for RS485.

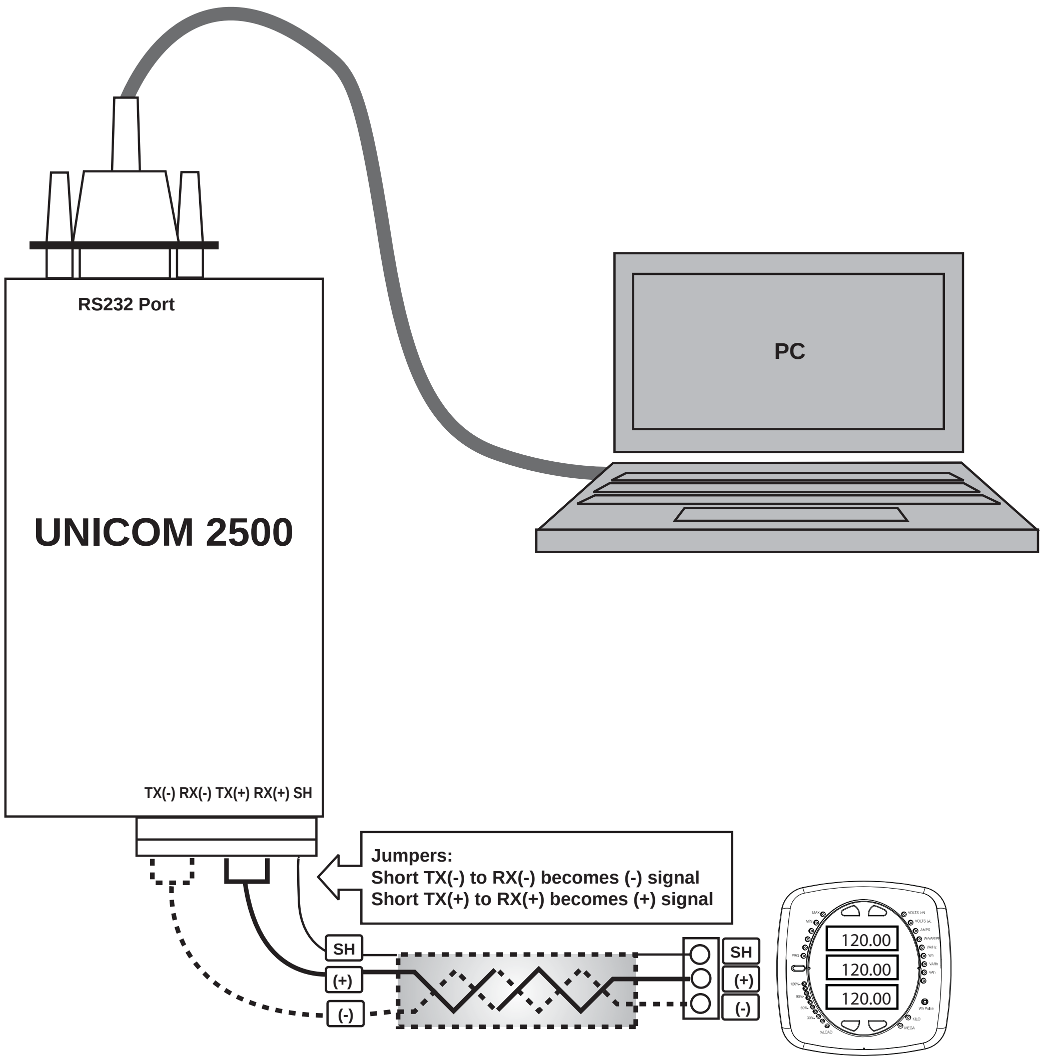
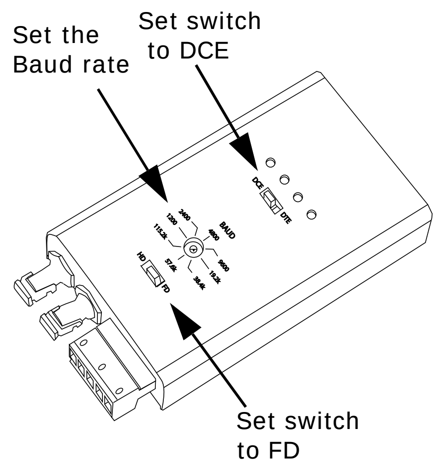


Figure 5.7: Unicom 2500 with Connections

The Unicom 2500 can be configured for either 4-wire or 2-wire RS485 connections. Since the Shark® 100 uses a 2-wire connection, you need to add jumper wires to convert the Unicom 2500 to the 2-wire configuration. As shown in Figure 5.7, you connect the “RX -” and “TX -” terminals with a jumper wire to make the “-” terminal, and connect the “RX +” and “TX +” terminals with a jumper wire to make the “+” terminal. See the figure on the right for the Unicom 2500’s settings. The Unicom’s Baud rate must match the Baud rate of the meter’s RS485 port: you set the Baud rate by turning the screw to point at the rate you want.



5.2: Shark® 100T Transducer Communication and Programming Overview

The Shark® 100T transducer does not include a display on the front face of the meter; there are no buttons or IrDA port on the face of the meter. Programming and communication utilize the RS485 connection on the back of the meter as shown in Section 5.1.2. Once a connection is established, Communicator EXT 3.0 software can be used to program the meter and communicate to Shark® 100T transducer slave devices.

Meter Connection

To provide power to the meter, attach an Aux cable to GND, L(+) and N(-) Refer to Section 4.8, Figure 1.

The RS485 cable attaches to SH, - and + as shown in Section 5.1.2.

5.2.1: Accessing the Meter in Default Communication Mode

You can connect to the Shark® 100T in Default communication mode. This feature is useful in debugging or if you do not know the meter's programmed settings and want to find them. For 5 seconds after the Shark® 100T is powered up, you can use the RS485 port with Default communication mode to poll the Name Register. You do this by connecting to the meter with the following default settings (see Section 5.2.2 on the next page):

Baud Rate: 9600

Address: 1

Protocol: Modbus RTU

The meter continues to operate with these default settings for 5 minutes. During this time, you can access the meter's Device Profile to ascertain/change meter information. After 5 minutes of no activity, the meter reverts to the programmed Device Profile settings.

IMPORTANT! In Normal operating mode the initial factory communication settings are:

Baud Rate: 57600

Address: 1

Protocol: Modbus RTU

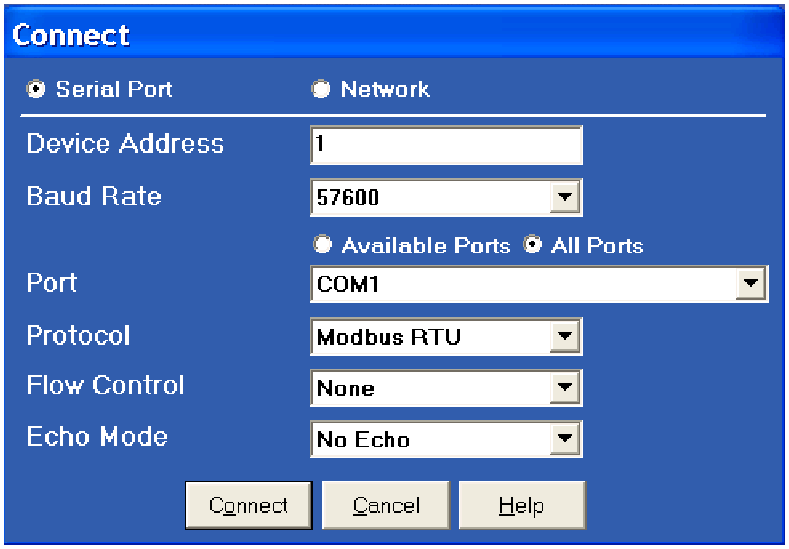
5.2.2: Connecting to the Meter through Communicator EXT

How to Connect:

1. Open Communicator EXT software.

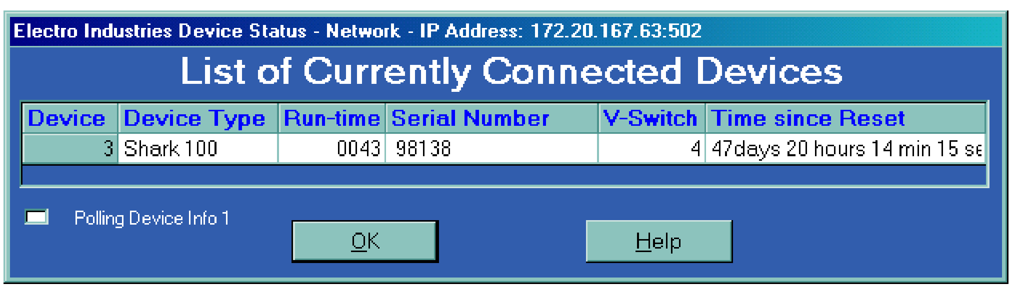
2. Click the **Connect** icon in the Icon bar.

3. The Connect screen opens, showing the Default settings. Make sure your settings are the same as shown here. Use the pull-down menus to make any necessary changes to the settings.



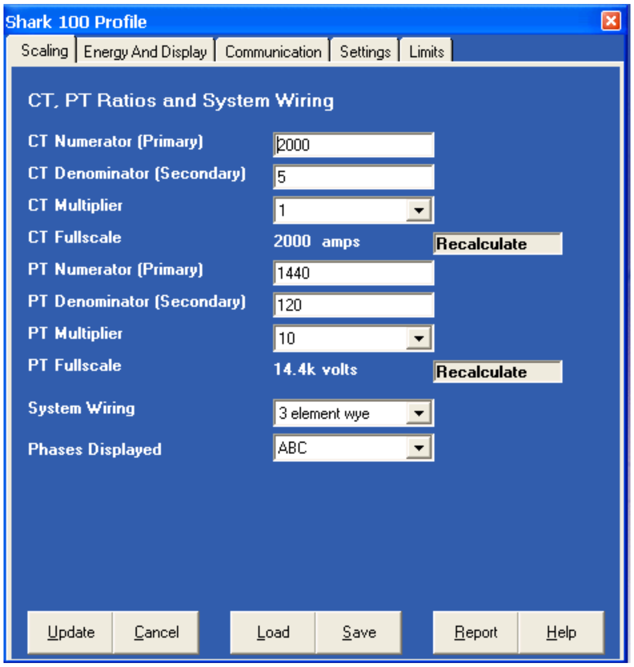
4. Click the **Connect** button. If you have a problem connecting, you may have to disconnect power to the meter, then reconnect power and click the **Connect** button, again.

5. You will see the Device Status screen, confirming connection to your meter. Click **OK**.

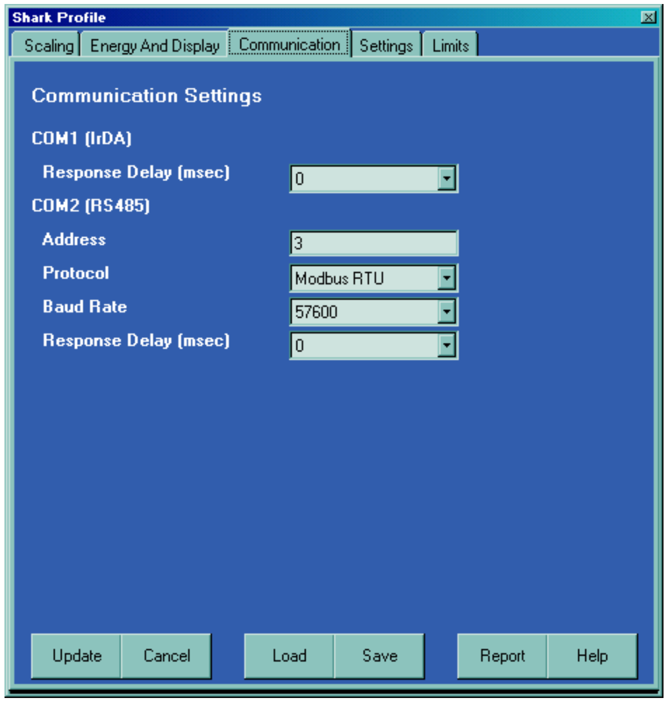


6. Click the **Profile** icon in the Title Bar.

7.You will see the Shark® 100 meter's Device Profile screen. The tabs at the top of the screen allow you to navigate between settings screens (see below).



8. Click the **Communications** tab. You will see the screen shown on the next page. Use this screen to enter communication settings for the meter's two on-board ports: the IrDA port (COM 1) and RS485 port (COM 2) Make any necessary changes to settings.



9. Valid Communication Settings are as follows:

COM1	(IrDA)
Response Delay	(0-750 msec)
COM2	(RS485)
Address	(1-247)
Protocol	(Modbus RTU, Modbus ASCII or DNP)
Baud Rate	(9600 to 57600)
Response Delay	(0-750 msec)

DNP Options for Voltage, Current, and Power - these fields allow you to choose Primary or Secondary Units for DNP, and to set custom scaling if you choose Primary. See Chapter 5 in the *Communicator EXT User Manual* for more information.

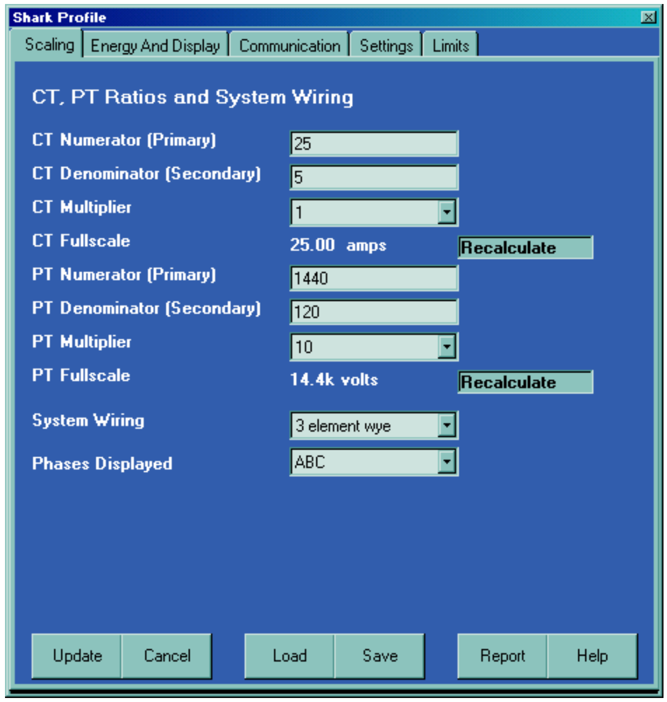
10. When changes are complete, click the **Update Device** button to send the new profile to the meter.

11. Click **Exit** to leave the Device Profile or click other menu items to change other aspects of the Device Profile (see the following section for instructions).

5.2.2: Shark® 100 Meter Device Profile Settings

NOTE: Only the basic Shark® 100 meter Device Profile settings are explained in this manual. Refer to Chapter 5 in the *Communicator EXT User Manual* for detailed instructions on configuring all settings of the meter's Device Profile. You can view the manual online by clicking **Help>Contents** from the Communicator EXT Main screen.

CT, PT Ratios and System Hookup



The screen fields and acceptable entries are as follows:

CT Ratios

CT Numerator (Primary): 1 - 9999

CT Denominator (Secondary): 5 or 1 Amp

NOTE: This field is display only.

CT Multiplier: 1, 10 or 100

Current Full Scale: Calculations based on selections. Click **Recalculate** to see the result of changes.

PT Ratios

PT Numerator (Primary): 1 - 9999

PT Denominator (Secondary): 40 - 600

PT Multiplier: 1, 10, 100, or 1000

Voltage Full Scale: Calculations based on selections. Click **Recalculate** to see the result of changes.

System Wiring

3 Element Wye; 2.5 Element Wye; 2 CT Delta

Phases Displayed

A, AB, or ABC

NOTE: Voltage Full Scale = PT Numerator x PT Multiplier

Example:

A 14400/120 PT would be entered as:

PT Numerator:	1440
PT Denominator:	120
Multiplier:	10

This example would display a 14.40kV.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200, Ct-Multiplier value for 1

800/5 Amps: Set the Ct-n value for 800, Ct-Multiplier value for 1

2,000/5 Amps: Set the Ct-n value for 2000, Ct-Multiplier value for 1

10,000/5 Amps: Set the Ct-n value for 1000, Ct-Multiplier value for 10

Example PT Settings:

277/277 Volts: Pt-n value is 277, Pt-d value is 277, Pt-Multiplier is 1

14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-Multiplier value is 10

138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-Multiplier value is 100

345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-Multiplier value is 100

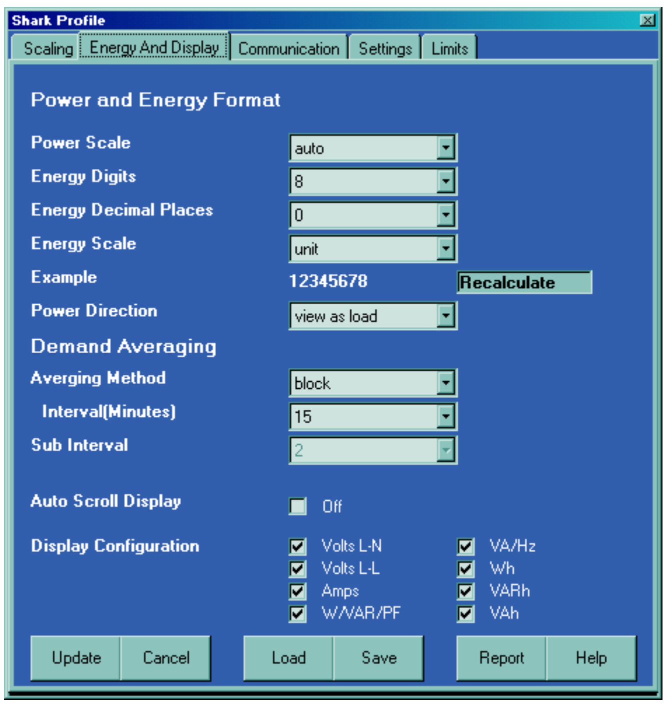
345,000/69 Volts: Pt-n value is 345, Pt-d value is 69, Pt-Multiplier value is 1000

NOTE: Settings are the same for Wye and Delta configurations.

Energy and Display

The settings on this screen determine the display configuration of the meter's faceplate.

NOTE: For a Shark® 100T transducer, the Display Configuration setting does not apply as there is no display.



The screen fields and acceptable entries are as follows:

Power and Energy Format

Power Scale: Unit, kilo (k), Mega (M), or auto.

Energy Digits: 5, 6, 7, or 8

Energy Decimal Places: 0-6

Energy Scale: Unit, kilo (k), or Mega (M)

For Example: a reading for Digits: 8; Decimals: 3; Scale: k would be formatted:

00123.456k

Power Direction: View as Load or View as Generator

Demand Averaging

Averaging Method: Block or Rolling

Interval (Minutes): 5, 15, 30, or 60

Sub Interval (if Rolling is selected): 1-4

Auto Scroll

Click to set On or Off.

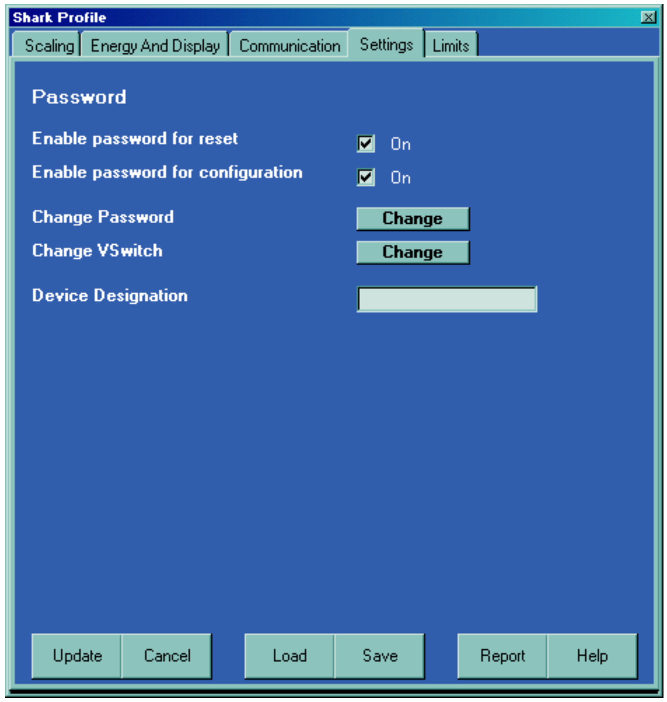
Display Configuration:

Click Values to be displayed.

NOTE: You MUST select at least ONE.

NOTE: If incorrect values are entered on this screen the following message appears:
WARNING: Current, CT, PT and Energy Settings will cause invalid energy accumulator values.
Change the settings until the message disappears.

Settings



The screen fields are as follows:

Password

NOTE: The meter is shipped with Password Disabled. There is NO DEFAULT PASSWORD.

Enable Password for Reset: click to Enable.

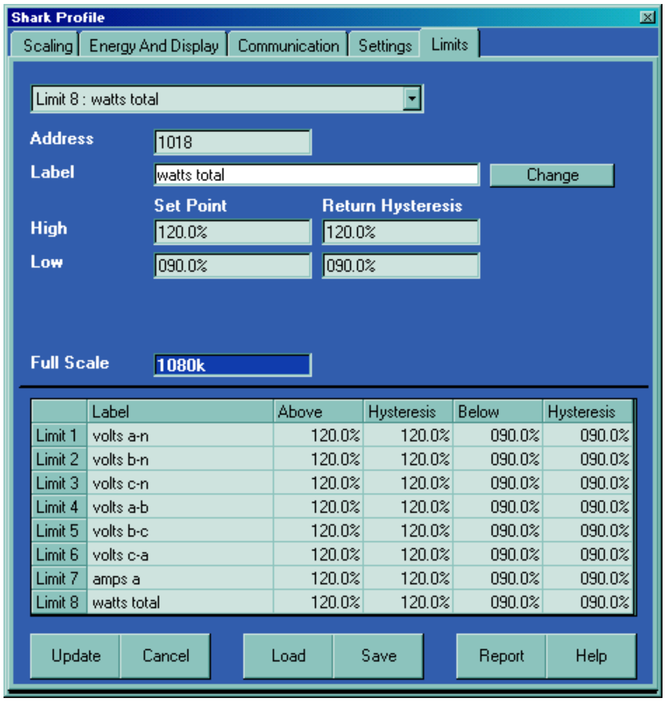
Enable Password for Configuration: click to Enable.

Change Password: click to Change.

Change VSwitch: click to Change (see Section 2.1.3 for instructions).

Device Designation: optional user-assigned label.

Limits (V-Switch™ Key 4 Only)



Limits are transition points used to divide acceptable and unacceptable measurements. When a value goes above or below the limit, an out-of-limit condition occurs. Once they are configured, you can view the out-of-Limits (or Alarm) conditions in the Limits Log or Limits Polling screen. You can also use Limits to trigger relays. See the *Communicator EXT User Manual* for details.

For up to 8 Limits, set:

Address: Modbus Address (1 based)

Label: Your designation for the limit

High Set Point: % of Full Scale

> **Example**: 100% of 120VFS = 120V; 90% of 120V FS = 108V

Return Hysteresis: Point to go back in Limit

> **Example**: High Set Point = 110% (Out of Limit at 132V);Return Hysteresis = 105%(Stay Out until 126V)

Low Set Point: % of Full Scale

Return Hysteresis: Point to go back in Limit.

Your settings appear in the Table at the bottom of the screen

NOTES: If Return Hysteresis is > High Set Point, the Limit is Disabled.

IMPORTANT! When you have finished making changes to the Device Profile, click **Update Device** to send the new Profile settings to the meter.

NOTE: Refer to Chapter 5 of the Communicator EXT User's Manual for additional instructions on configuring the Shark® 100 meter settings.

5.3: Configuring the Ethernet Connection (INP10 option)

The INP10 option gives the Shark ® 100/100T meter a wired (RJ45) Ethernet connection, allowing it to communicate on a Local Area Network (LAN). The meter is easily configured through a host PC using a Telnet connection. Once configured, you can access the meter directly through any computer on your LAN.

This section outlines the procedures for setting up the parameters for Ethernet communication:

- Host PC setup - Section 5.3.1
- Shark® 100 meter setup - Section 5.3.2

5.3.1: Setting up the Host PC to Communicate with the Shark® meter

Consult with the network administrator before performing these steps because some of the functions may be restricted to Administrator privileges.

The Host PC could have multiple Ethernet Adapters (Network Cards) installed. Identify and configure the one that will be used for accessing the Shark® meter.

The PC's Ethernet Adapter must be set up for point-to-point communication when configuring the Shark® meter's INP10 option. The Factory Default IP parameters programmed in the INP10 card are:

IP Address: 10.0.0.1

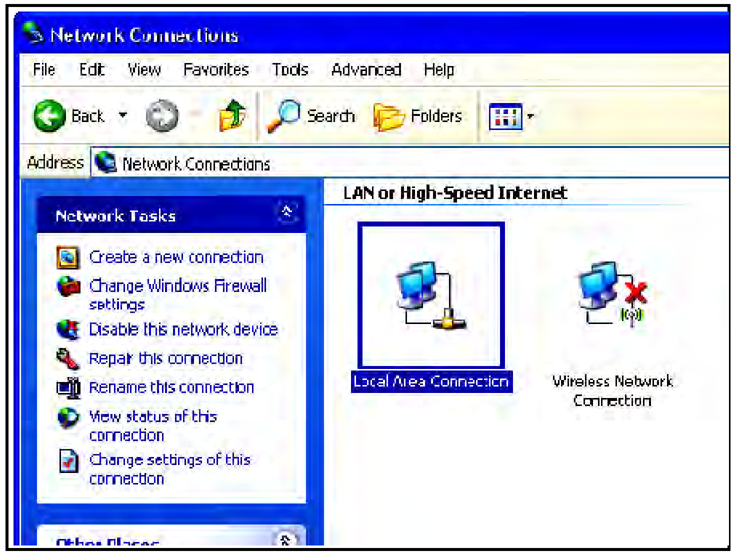
Subnet Mask: 255.255.255.0

See Section 5.3.2. for additional parameters.

5.3.1.1: Configuring the Host PC's Ethernet Adapter Using Windows XP©

The following example shows the PC configuration settings that allow you to access the Shark® 100 meter configured with default parameters. Use the same procedure when the settings differ from the default settings.

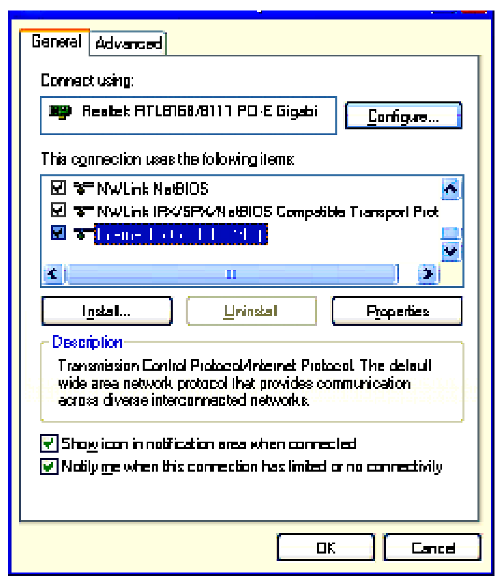
1.From the Start Menu, select **Control Panel>Network Connections**. You will see the window shown on the right.



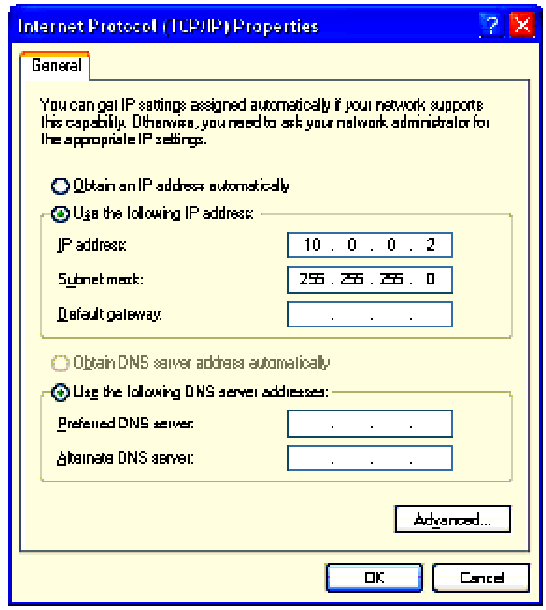
2. Right click on the Local Area Network Connection you will use to connect to the Shark® 100 meter and select **Properties** from the drop-down menu.

3. You will see the window shown on the right.

Select Internet Protocol [TCP/IP] and click the **Properties** button.



4. You will see the window shown on the right. Click the **Use the Following IP Address** radio button and enter these parameters:
   IP Address: 10.0.0.2
   Subnet Mask: 255.255.255.0



5. Click the **OK** button. You have completed the setup procedure.

5.3.2: Setting up the Ethernet Card (INP10 option) in the Shark® meter

Below are the Factory Default settings for the Shark® 100 meter's Ethernet card. These are programmed into the meter before it is shipped out from the factory. Parameters in group 1 may need to be altered to satisfy the local Ethernet configuration requirements. **Other parameters (2, 3, 4) should not be altered.**

1) Network/IP Settings:
IP Address ....…... 10.0.0.1
Default Gateway .... --- not set ---
Netmask .... …255.255.255.0
2) Serial & Mode Settings:
Protocol .... Modbus/RTU,Slave(s) attached
Serial Interface 57600,8,N,1,RS232
3) Modem/Configurable Pin Settings:
CP1…………..Not Used
CP2…………..Not Used
CP3…………..Not Used
4) Advanced Modbus Protocol settings:
Slave Addr/Unit Id Source .. Modbus/TCP header
Modbus Serial Broadcasts ... Disabled (Id=0 auto-mapped to 1)
MB/TCP Exception Codes ..... Yes (return 00AH and 00BH)
Char, Message Timeout 00050msec, 05000msec

The Ethernet card in the Shark® 100 meter can be locally or remotely configured using a Telnet connection over the network.

The configuration parameters can be changed at any time and are retained when the meter is not powered up. After the configuration has been changed and saved, the Ethernet card performs a reset.

Only one person at a time should be logged into the network port used for setting up the meter. This eliminates the possibility of several people trying to configure the Ethernet interface simultaneously.

It is possible to reset the Ethernet card to its default values. See the procedure on page 5-22.

5.3.2.1: Configuring the Shark® 100 Meter's Ethernet Connection using Windows XP© on the Host Computer

Establish a Telnet connection on port 9999. Follow these steps:

1. From the Windows Start menu, click **Run** and type 'cmd'.

2. Click the **OK** button to bring up the Windows' Command Prompt window.

3. In the Command Prompt window, type: “telnet 10.0.0.1 9999" and press the **Enter** key.
   NOTE: Make sure there is a space between the IP address and 9999.
   When the Telnet connection is established you will see a message similar to the example shown below.

```
Serial Number 5415404  MAC Address  00:20:4A:54:3C:2C
Software Version V01.2 (000719)
Press Enter to go into Setup Mode
```

4. To proceed to Setup Mode press Enter again. You will see a screen similar to the one shown on the next page.

```
1) Network/IP Settings:
     IP Address ................….. 10.0.0.1
     Default Gateway ............--- not set ---
     Netmask ......................…255.255.255.0
2) Serial & Mode Settings:
     Protocol ...................... Modbus/RTU,Slave(s) attached
     Serial Interface ........... 57600,8,N,1,RS232,CH1
3) Modem/Configurable Pin Settings:
     CP1…………..Not Used
     CP2…………..Not Used
     CP3…………..Not Used
4) Advanced Modbus Protocol settings:
     Slave Addr/Unit Id Source .. Modbus/TCP header
     Modbus Serial Broadcasts ... Disabled (Id=0 auto-mapped to 1)
     MB/TCP Exception Codes ..... Yes (return 00AH and 00BH)
     Char, Message Timeout ...... 00050msec, 05000msec

D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..4) to change:
```

5. Change ONLY the parameters in group 1. To do so:

a. Type number "**1**."

b. Once group 1 is selected, the individual parameters display for editing. Either:

- Enter a new parameter if a change is required.
- Press **Enter** to proceed to the next parameter without changing the current setting.

IMPORTANT! Settings 2, 3, and 4 must have the default values shown above.

(**Example**: Setting device with static IP Address.)

IP Address <010> 192.<000> 168.<000> .<000> .<001>

Set Gateway IP Address <N>? Y

Gateway IP Address: <192> .<168> .<000> .<001>

Set Netmask <N for default> <Y>? Y

6. Continue setting up parameters as needed. After you finish your modifications, make sure to press the "**S**" key on the keyboard. This saves the new values and causes a Reset in the Ethernet card.

CAUTION! DO NOT PRESS 'D' as it will overwrite any changes and save the default values.

IMPORTANT! If the IP Address of the Ethernet card is lost, you can restore the factory default settings by pressing the Reset button on the card. Follow the procedure in the following section.

5.3.2.2: Resetting the Ethernet Card (INP10)

The INP10 card's **Reset** button is accessed from the back of the Shark® 100 meter. See the figure below.

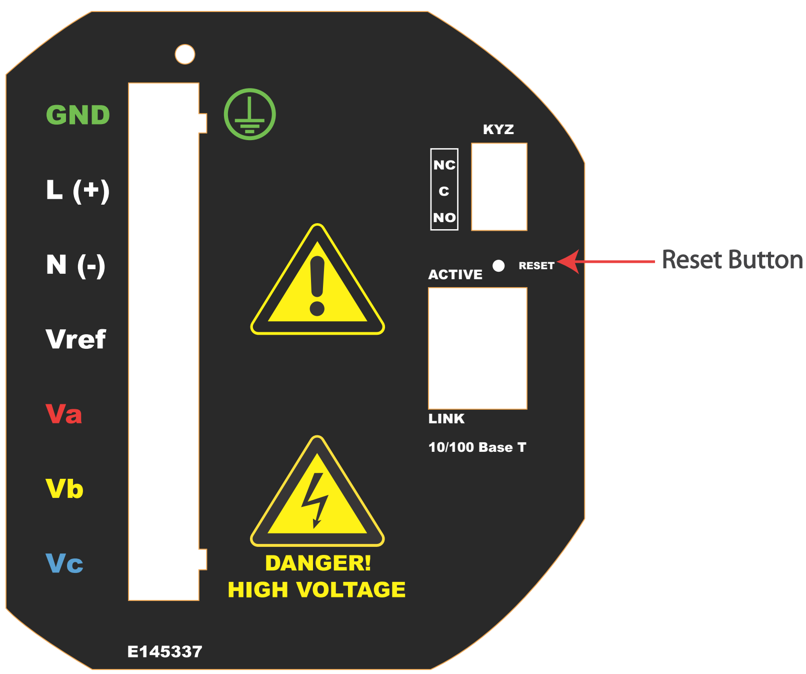


Figure 5.8: Backplate of Shark® 100 meter, showing Reset button

Using an implement such as a ballpoint pen tip, press and hold the **Reset** button for 30 seconds. The INP10 card will be reset to the default settings shown in Section 5.3.2.

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6: Using the Shark® 100 Meter

6.1: Introduction

You can use the Elements and Buttons on the Shark® 100 meter's face to view meter readings, reset and/or configure the meter, and perform related functions. The following sections explain the Elements and Buttons and detail their use.

6.1.1: Understanding Meter Face Elements

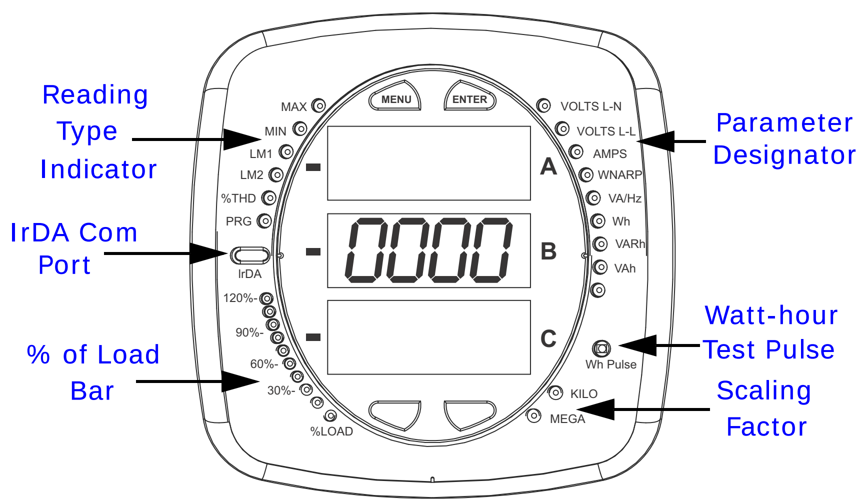


Figure 6.1: Faceplate with Elements

The meter face features the following elements:

- Reading Type Indicator: e.g., Max
- Parameter Designator: e.g., Volts L-N
- Watt-Hour Test Pulse: Energy pulse output to test accuracy
- Scaling Factor: Kilo or Mega multiplier of displayed readings
- % of Load Bar: Graphic display of Amps as % of the Load (Refer to Section 6.3 for additional information.)
- IrDA Communication Port: Com 1 port for wireless communication

6.1.2: Understanding Meter Face Buttons

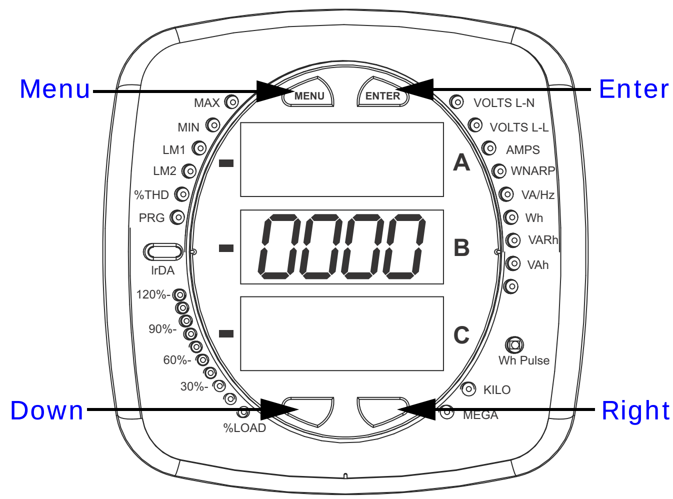


Figure 6.2: Faceplate with Buttons

The meter face has **Menu**, **Enter**, **Down** and **Right** buttons, which let you perform the following functions:

- View Meter Information
- Enter Display Modes
- Configure Parameters (may be Password Protected)
- Perform Resets (may be Password Protected)
- Perform LED Checks
- Change Settings
- View Parameter Values
- Scroll Parameter Values
- View Limit States

6.2: Using the Front Panel

You can access four modes using the Shark® 100 meter's front panel buttons:

- Operating mode (Default)
- Reset mode
- Configuration mode
- Information mode - Information mode displays a sequence of screens that show model information, such as Frequency, Amps, V-Switch, etc.

Use the **Menu**, **Enter**, **Down** and **Right** buttons to navigate through each mode and its related screens.

NOTES:

- See Appendix A for the complete display mode Navigation maps.
- The meter can also be configured using software; see Chapter 5 and the *Communicator EXT User Manual* for instructions.

6.2.1: Understanding Startup and Default Displays

Upon Power Up, the meter displays a sequence of screens:

- Lamp Test screen where all LEDs are lit
- Lamp Test screen where all digits are lit
- Firmware screen showing build number
- Error screen (if an error exists)

After startup, if auto-scrolling is enabled, the Shark® 100 meter scrolls the parameter readings on the right side of the front panel. The Kilo or Mega LED lights, showing the scale for the Wh, VARh and VAh readings. Figure 6.3 shows an example of a Wh reading.

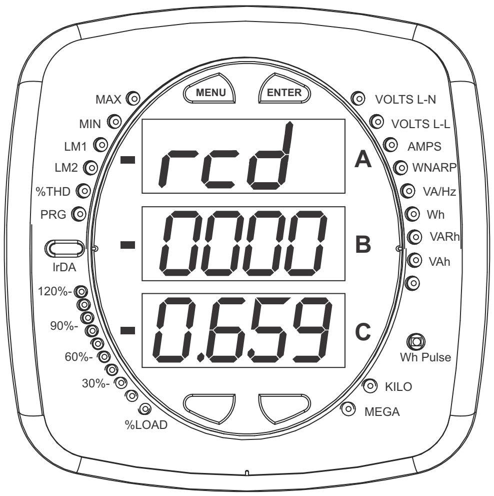


Figure 6.3: Display Showing Watt-hr Reading

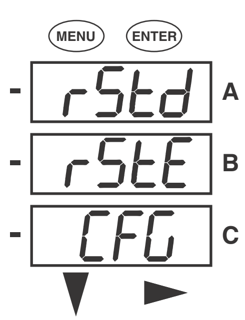
The Shark® 100 meter continues to provide scrolling readings until one of the buttons on the front panel is pressed, causing the meter to enter one of the other modes.

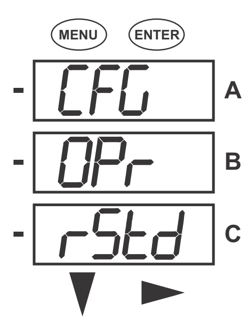
6.2.2: Using the Main Menu

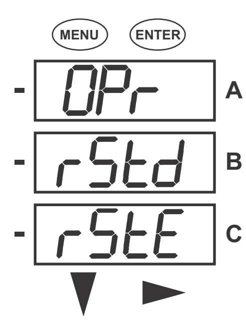
1. Press the **Menu** button. The Main Menu screen appears.

- The Reset: Demand mode (rStd) appears in the A window. Use the Down button to scroll, causing the Reset: Energy (rStE), Configuration (CFG), Operating (OPr), and Information (InFo) modes to move to the A window.

- The mode that is currently flashing in the A window is the “Active” mode, which means it is the mode that can be configured.







For example: Press Down Twice - CFG moves to A window. Press Down Twice - OPr moves to A window.

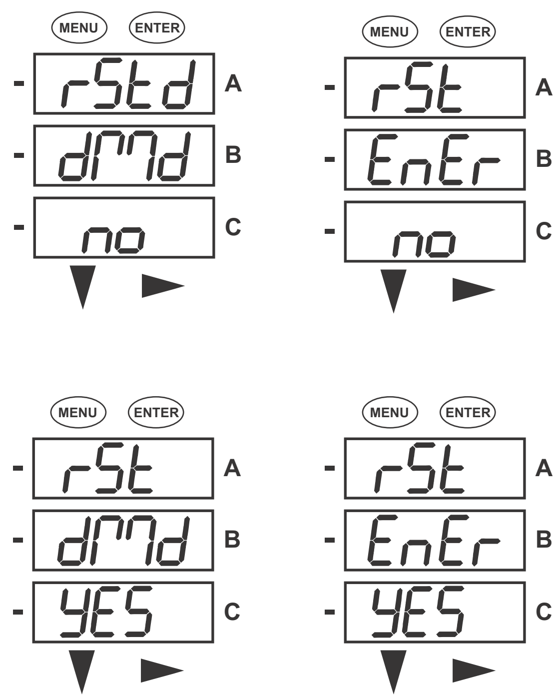
2. Press the **Enter** button from the Main Menu to view the Parameters screen for the mode that is currently active.

6.2.3: Using Reset Mode

Reset mode has two options:

- Reset: Demand (rStd): resets the Max and Min values.
- Reset: Energy (rStE): resets the energy accumulator fields.

1. Press the Enter button while either rStd or rStE is in the A window. The Reset Demand No or Reset Energy No screen appears.
   - If you press the **Enter** button again, the Main Menu appears, with the next mode in the A window. (The **Down** button does not affect this screen.)
   - If you press the **Right** button, the Reset Demand YES or Reset Energy YES screen appears. Press **Enter** to perform a reset.



NOTE: If Password protection is enabled for reset, you must enter the four digit password before you can reset the meter (see Chapter 5 for information on Password protection). To enter a password, follow the instructions in Section 6.2.4.

CAUTION! Reset Demand YES resets **all** Max and Min values.

2. Once you have performed a reset, the screen displays either “rSt dMd donE” or “rSt EnEr donE”and then resumes auto-scrolling parameters.

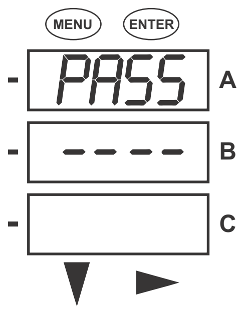
6.2.4: Entering a Password

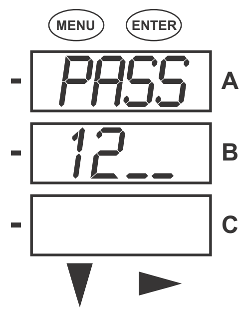
If Password protection has been enabled in the software for reset and/or configuration (see Chapter 5 for more information), a screen appears requesting a password when you try to reset the meter and/or configure settings through the front panel.

- PASS appears in the A window and 4 dashes appear in the B window. The leftmost dash is flashing.

1. Press the **Down** button to scroll numbers from 0 to 9 for the flashing dash. When the correct number appears for that dash, use the **Right** button to move to the next dash.

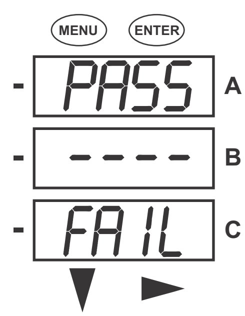
Example: The left screen, below, shows four dashes. The right screen shows the display after the first two digits of the password have been entered.





2. When all 4 digits of the password have been selected, press the **Enter** button.

- If you are in Reset Mode and you enter the correct password, “rSt dMd donE” or “rSt EnEr donE”appears and the screen resumes auto-scrolling parameters.
- If you are in Configuration Mode and you enter the correct password, the display returns to the screen that required a password.
- If you enter an incorrect password, “PASS ---- FAIL” appears and:
  - The previous screen is re-displayed, if you are in Reset Mode.
  - The previous Operating mode screen is re-displayed, if you are in Configuration mode.



6.2.5: Using Configuration Mode

Configuration mode follows Reset: Energy on the Main Menu.

To access Configuration mode

1. Press the **Menu** button while the meter is auto-scrolling parameters.

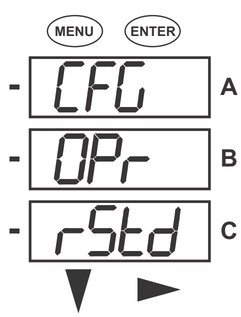
2. Press the **Down** button until the Configuration Mode option (CFG) is in the A window.

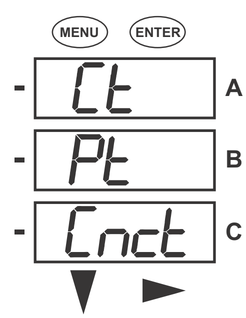
3. Press the **Enter** button. The Configuration Parameters screen appears.

4. Press the **Down** button to scroll through the configuration parameters: Scroll (SCrL), CT, PT, Connection (Cnct) and Port. The parameter currently ‘Active,” i.e., configurable, flashes in the A window.

5. Press the **Enter** button to access the Setting screen for the currently active parameter.

NOTE: You can use the **Enter** button to scroll through all of the Configuration parameters and their Setting screens, in order.





Press **Enter** when CFG is in A window - Parameter screen appears -

Press **Down**- Press **Enter** when

Parameter you want is in A window

6. The parameter screen appears, showing the current settings. To change the settings:

   - Use either the **Down** button or the **Right** button to select an option.

- To enter a number value, use the **Down** button to select the number value for a digit and the **Right** button to move to the next digit.

NOTE: When you try to change the current setting and Password protection is enabled for the meter, the Password screen appears. See Section 6.2.4 for instructions on entering a password.

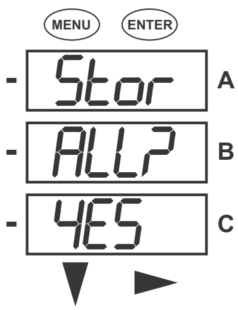
7. Once you have entered the new setting, press the **Menu** button twice.

8. The Store ALL YES screen appears. You can either:

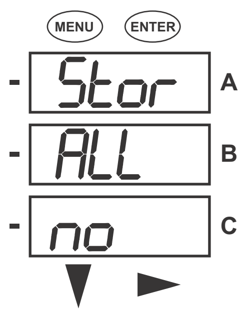
    - Press the **Enter** button to save the new setting.

    - Press the **Right** button to access the Store ALL no screen; then press the **Enter** button to cancel the Save.

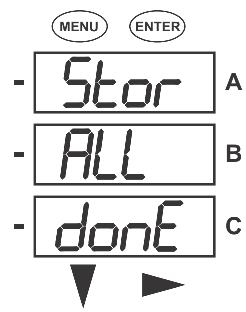
9. If you have saved the settings, the Store ALL done screen appears and the meter resets.



Press the **Enter** button to save the settings. Press the **Right** button for Stor All no screen.



Press the **Enter** button to Cancel the Save.



The settings have been saved.

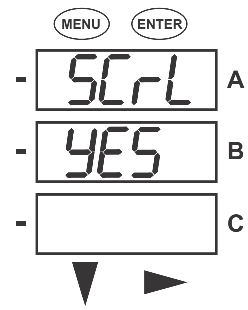
6.2.5.1: Configuring the Scroll Feature

When in Auto Scroll mode, the meter performs a scrolling display, showing each parameter for 7 seconds, with a 1 second pause between parameters. The parameters that the meter displays are determined by the following conditions:

- They have been selected through software (refer to the *Communicator EXT User Manual* for instructions).

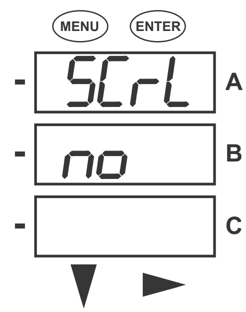
- They are enabled by the installed V-Switch™ key. Refer to Section 2.1.3 for information on V-Switch™ keys.

To enable or disable Auto-scrolling:



1. Press the **Enter** button when SCrl is in the A window. The Scroll YES screen appears.

2. Press either the **Right** or **Down** button if you want to access the Scroll no screen. To return to the Scroll YES screen, press either button.



3. Press the **Enter** button on either the Scroll YES screen (to enable auto-scrolling) or the Scroll no screen (to disable auto-scrolling).

4. The CT- n screen appears (this is the next Configuration mode parameter).

NOTES:

- To exit the screen without changing scrolling options, press the **Menu** button.

- To return to the Main Menu screen, press the **Menu** button twice.

- To return to the scrolling (or non-scrolling) parameters display, press the **Menu** button three times.

6.2.5.2: Configuring CT Setting

The CT Setting has three parts: Ct-n (numerator), Ct-d (denominator), and Ct-S (scaling).

1. Press the **Enter** button when Ct is in the A window. The Ct-n screen appears. You can either:

   - Change the value for the CT numerator.
   - Access one of the other CT screens by pressing the **Enter** button: press **Enter** once to access the Ct-d screen, twice to access the Ct-S screen.

     NOTE: The Ct-d screen is preset to a 5 amp or 1 amp value at the factory and cannot be changed.

   a. To change the value for the CT numerator:

      From the Ct-n screen:

      - Use the Down button to select the number value for a digit.
      - Use the Right button to move to the next digit.

   b. To change the value for CT scaling

      From the Ct-S screen:

      Use the **Right** button or the **Down** button to choose the scaling you want. The Ct-S setting can be 1, 10, or 100.

NOTE: If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. The Store ALL YES screen appears. Press **Enter** to save the new CT setting.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200 and the Ct-S value for 1.

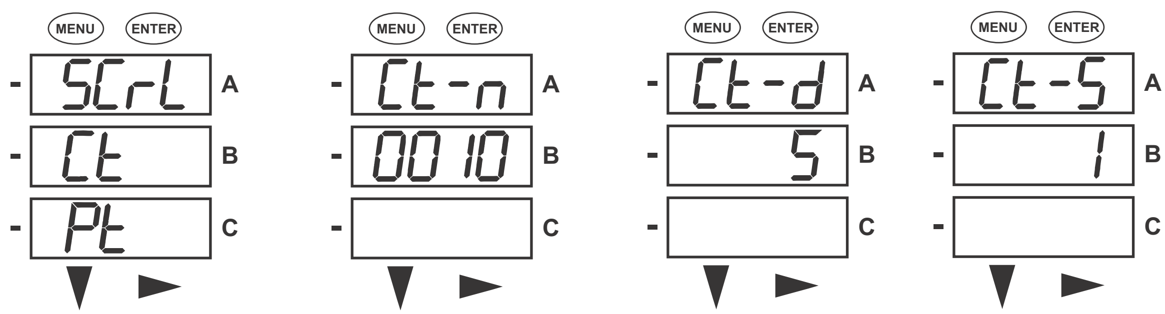
800/5 Amps: Set the Ct-n value for 800 and the Ct-S value for 1.

2,000/5 Amps: Set the Ct-n value for 2000 and the Ct-S value for 1.

10,000/5 Amps: Set the Ct-n value for 1000 and the Ct-S value for 10.

NOTES:

- The value for Amps is a product of the Ct-n value and the Ct-S value.
- Ct-n and Ct-S are dictated by primary current; Ct-d is secondary current.



Press **Enter** | Use buttons to set Ct-n | Ct-d cannot be changed | Use buttons to select scaling

6.2.5.3: Configuring PT Setting

The PT Setting has three parts: Pt-n (numerator), Pt-d (denominator), and Pt-S (scaling).

1. Press the **Enter** button when Pt is in the A window. The PT-n screen appears. You can either:

   - Change the value for the PT numerator.
   - Access one of the other PT screens by pressing the **Enter** button: press **Enter** once to access the Pt-d screen, twice to access the Pt-S screen.

   a. To change the value for the PT numerator or denominator:

   From the Pt-n or Pt-d screen:

   - Use the **Down** button to select the number value for a digit.
   - Use the **Right** button to move to the next digit.

b. To change the value for the PT scaling:

From the Pt-S screen:

Use the **Right** button or the **Down** button to choose the scaling you want. The Pt-S setting can be 1, 10, 100, or 1000.

NOTE: If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. The STOR ALL YES screen appears. Press **Enter** to save the new PT setting.

Example PT Settings:

277/277 Volts: Pt-n value is 277, Pt-d value is 277, Pt-S value is 1.

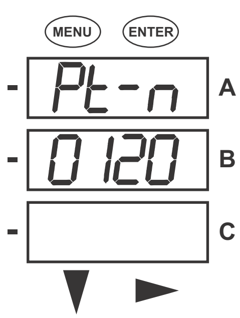
14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.

138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.

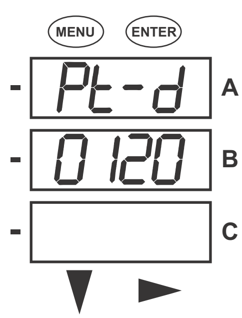
345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.

345,000/69 Volts: Pt-n value is 345, Pt-d value is 69, Pt-S value is 1000.

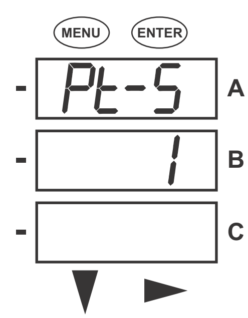
NOTE: Pt-n and Pt-S are dictated by primary Voltage; Pt-d is secondary Voltage.



Use buttons to set Pt-n



Use buttons to set Pt-d



Use buttons to select scaling

6.2.5.4: Configuring Connection Setting

1. Press the **Enter** button when Cnct is in the A window. The Cnct screen appears.

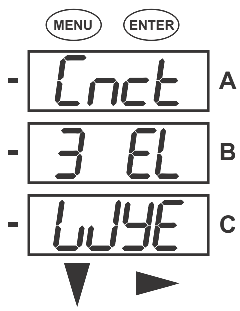
2. Press the **Right** button or **Down** button to select a configuration. The choices are:

    - 3 Element Wye (3 EL WYE)
    - 2.5 Element Wye (2.5EL WYE)
    - 2 CT Delta (2 Ct dEL)

NOTE: If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

3. When you have made your selection, press the **Menu** button twice.

4. The STOR ALL YES screen appears. Press **Enter** to save the setting.



Use buttons to select configuration

6.2.5.5: Configuring Communication Port Setting

Port configuration consists of: Address (a three digit number), Baud Rate (9600; 19200; 38400; or 57600), and Protocol (DNP 3.0; Modbus RTU; or Modbus ASCII).

1. Press the **Enter** button when POrt is in the A window. The Adr (address) screen appears. You can either:

    - Enter the address.
    - Access one of the other Port screens by pressing the **Enter** button: press **Enter** once to access the bAUd screen (Baud Rate), twice to access the Prot screen (Protocol).

a. To enter the Address

From the Adr screen:

- Use the **Down** button to select the number value for a digit.
- Use the **Right** button to move to the next digit.

b. To select the Baud Rate:

From the bAUd screen:

Use the **Right** button or the **Down** button to select the setting you want.

c. To select the Protocol:

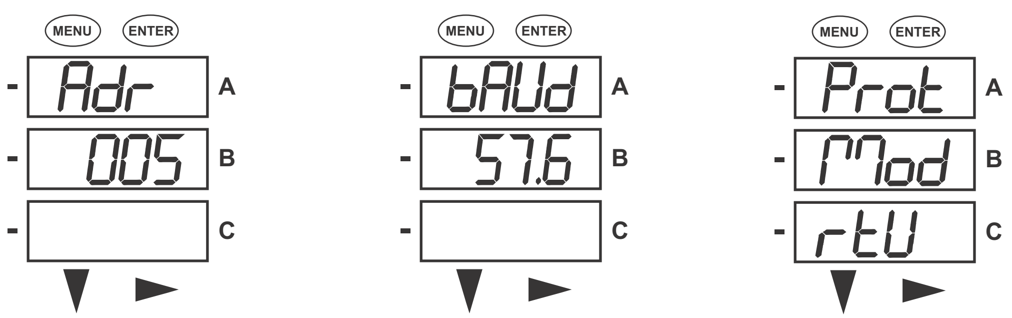
From the Prot screen:

Press the **Right** button or the **Down** button to select the setting you want.

NOTE: If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

2. When you have finished making your selections, press the **Menu** button twice.

3. The STOR ALL YES screen appears. Press **Enter** to save the settings.



Use buttons to enter Address   Use buttons to select Baud Rate   Use buttons to select Protocol

6.2.6: Using Operating Mode

Operating mode is the Shark® 100 meter's default mode, that is, the standard front panel display. After starting up, the meter automatically scrolls through the parameter screens, if scrolling is enabled. Each parameter is shown for 7 seconds, with a 1 second pause between parameters. Scrolling is suspended for 3 minutes after any button is pressed.

1. Press the **Down** button to scroll all the parameters in Operating mode. The currently "Active," i.e., displayed, parameter has the Indicator light next to it, on the right face of the meter.

2. Press the **Right** button to view additional readings for that parameter. The table below shows possible readings for Operating mode. Sheet 2 in Appendix A shows the Operating mode Navigation map.

NOTE: Readings or groups of readings are skipped if not applicable to the meter type or hookup, or if they are disabled in the programmable settings.

OPERATING MODE PARAMETER READINGS

POSSIBLE READINGS

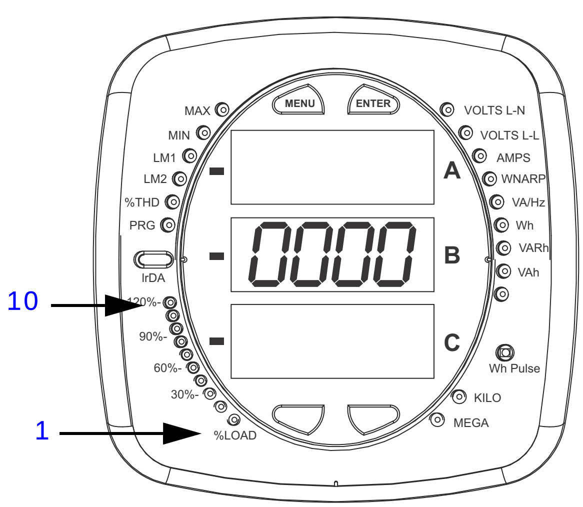
VOLTS L-N	VOLTS_LN	VOLTS_LN_ MAX	VOLTS_LN_ MIN		VOLTS_LN_ THD
VOLTS L-L	VOLTS_LL	VOLTS_LL_ MAX	VOLTS_LL_ MIN		
AMPS	AMPS	AMPS_NEU TRAL	AMPS_MAX	AMPS_MIN	AMPS_THD
W/VAR/PF	W_VAR_PF	W_VAR_PF _MAX_POS	W_VAR_PF _MIN_POS	W_VAR_PF _MIN_NEG	
VA/Hz	VA_FREQ	VA_FREQ_ MAX	VA_FREQ_ MIN		
Wh	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT	
VARh	KVARH_PO S	KVARH_NE G	KVARH_NE T	KVARH_TO T	
VAh	KVAH				

6.3: Understanding the % of Load Bar

The 10-segment LED bar graph at the bottom left of the Shark® 100 meter's front panel provides a graphic representation of Amps. The segments light according to the load, as shown in the table below.

When the Load is over 120% of Full Load, all segments flash "On" (1.5 secs) and "Off" (0.5 secs).

Segments	**Load >= % Full Load**
none	**no load**
1	1%
1-2	15%
1-3	30%
1-4	45%
1-5	60%
1-6	72%
1-7	84%
1-8	96%
1-9	108%
1-10	120%
All Blink	>120%



6.4: Performing Watt-Hour Accuracy Testing (Verification)

To be certified for revenue metering, power providers and utility companies must verify that the billing energy meter performs to the stated accuracy. To confirm the meter's performance and calibration, power providers use field test standards to ensure that the unit's energy measurements are correct. Since the Shark® 100 meter is a traceable revenue meter, it contains a utility grade test pulse that can be used to gate an accuracy standard. This is an essential feature required of all billing grade meters.

- Refer to Figure 6.5 for an example of how this process works.
- Refer to Table 6.1 for the Wh/Pulse constants for accuracy testing.

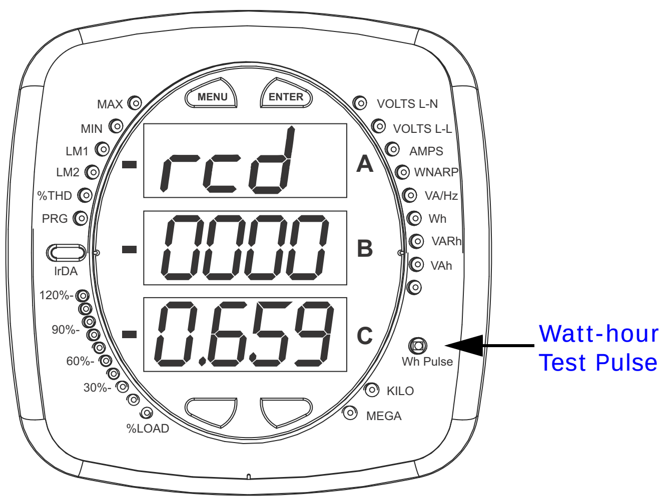


Figure 6.4: Watt-hour Test Pulse

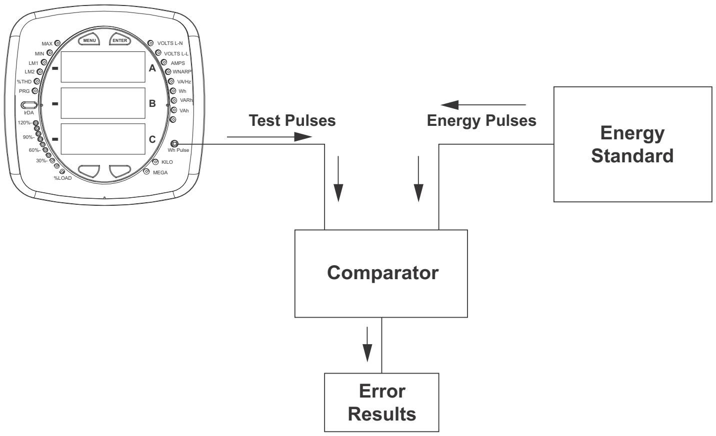


Figure 6.5: Using the Watt-hour Test Pulse

Input Voltage Level	Class 10 Models	Class 2 Models
Below 150V	0.2505759630	0.0501151926
Above 150V	1.0023038521	0.2004607704

Table 6.1: Infrared & KYZ Pulse Constants for Accuracy Testing - Kh Watt-hour per pulse

NOTES:

- Minimum pulse width is 40 milliseconds.
- Refer to Chapter 2, Section 2.2, for Wh Pulse specifications.

A: Shark® 100 Meter Navigation Maps

A.1: Introduction

You can configure the Shark® 100 meter and perform related tasks using the buttons on the meter face. Chapter 6 contains a description of the buttons on the meter face and instructions for programming the meter using them. The meter can also be programmed using software (see Chapter 5 and the *Communicator EXT User Manual*).

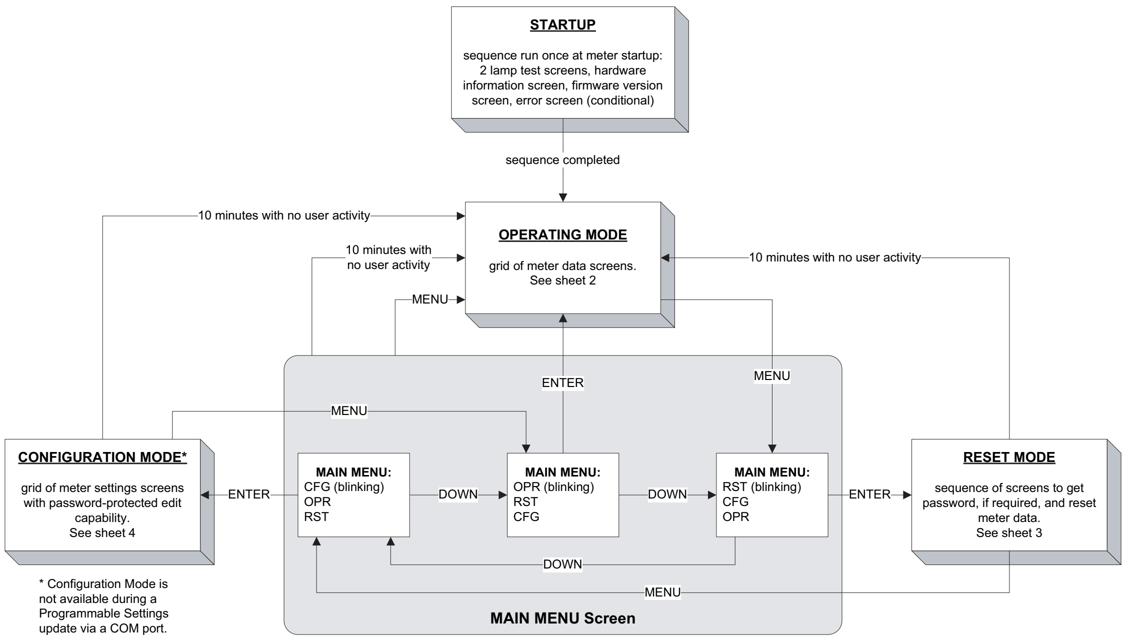
A.2: Navigation Maps (Sheets 1 to 4)

The Shark® 100 meter's Navigation maps begin on the next page. The maps show in detail how to move from one screen to another and from one display mode to another using the buttons on the face of the meter. All display modes automatically return to Operating mode after 10 minutes with no user activity.

Shark® 100 meter Navigation map titles

- Main Menu Screens (Sheet 1)
- Operating mode screens (Sheet 2)
- Reset mode screens (Sheet 3)
- Configuration mode screens (Sheet 4)

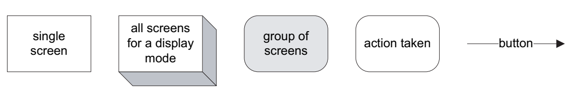
Main Menu Screens (Sheet 1)



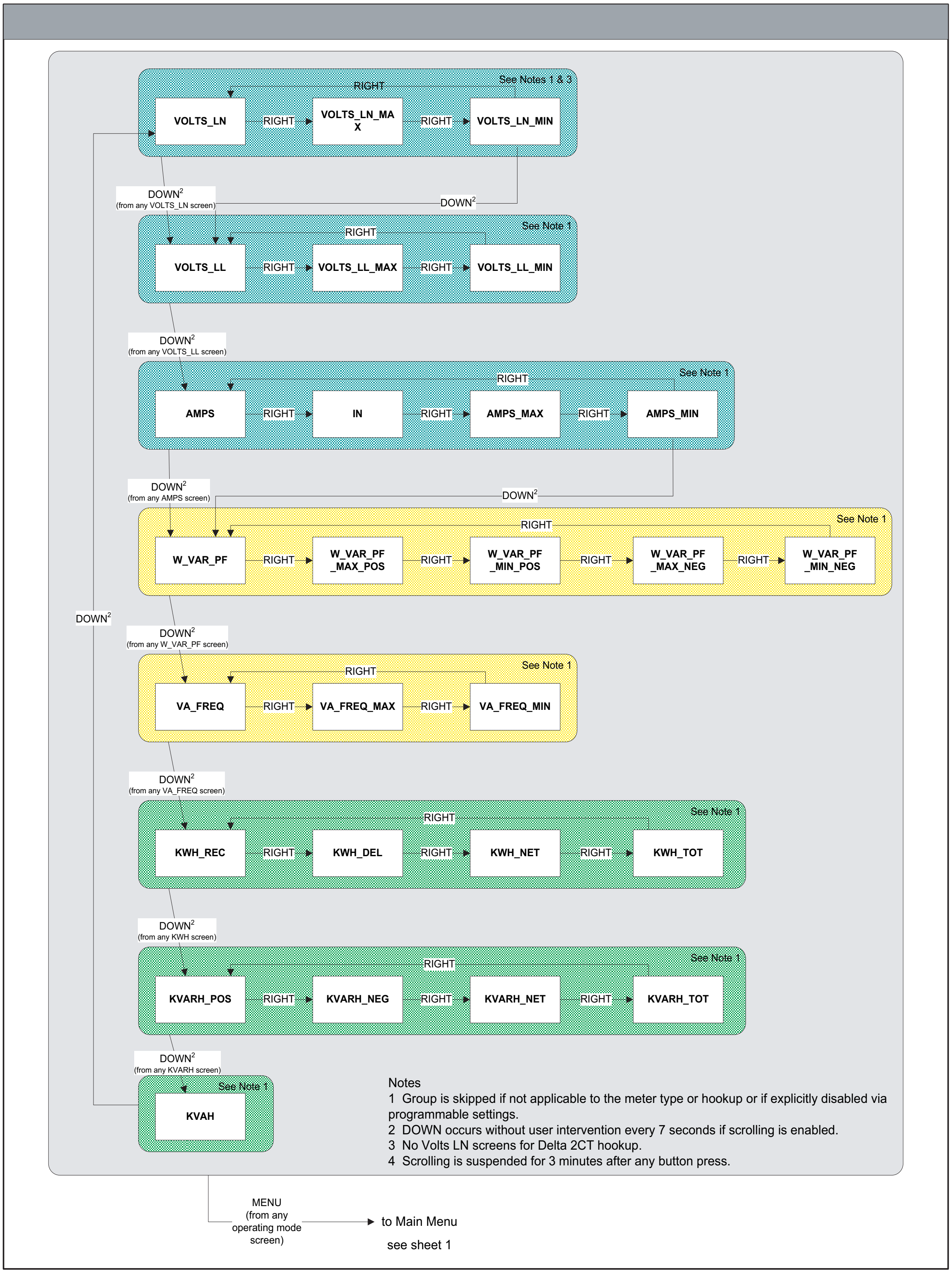
MAIN MENU screen scrolls through 3 choices, showing all 3 at once. The top choice is always the "active" one, which is indicated by blinking the legend.

BUTTONS

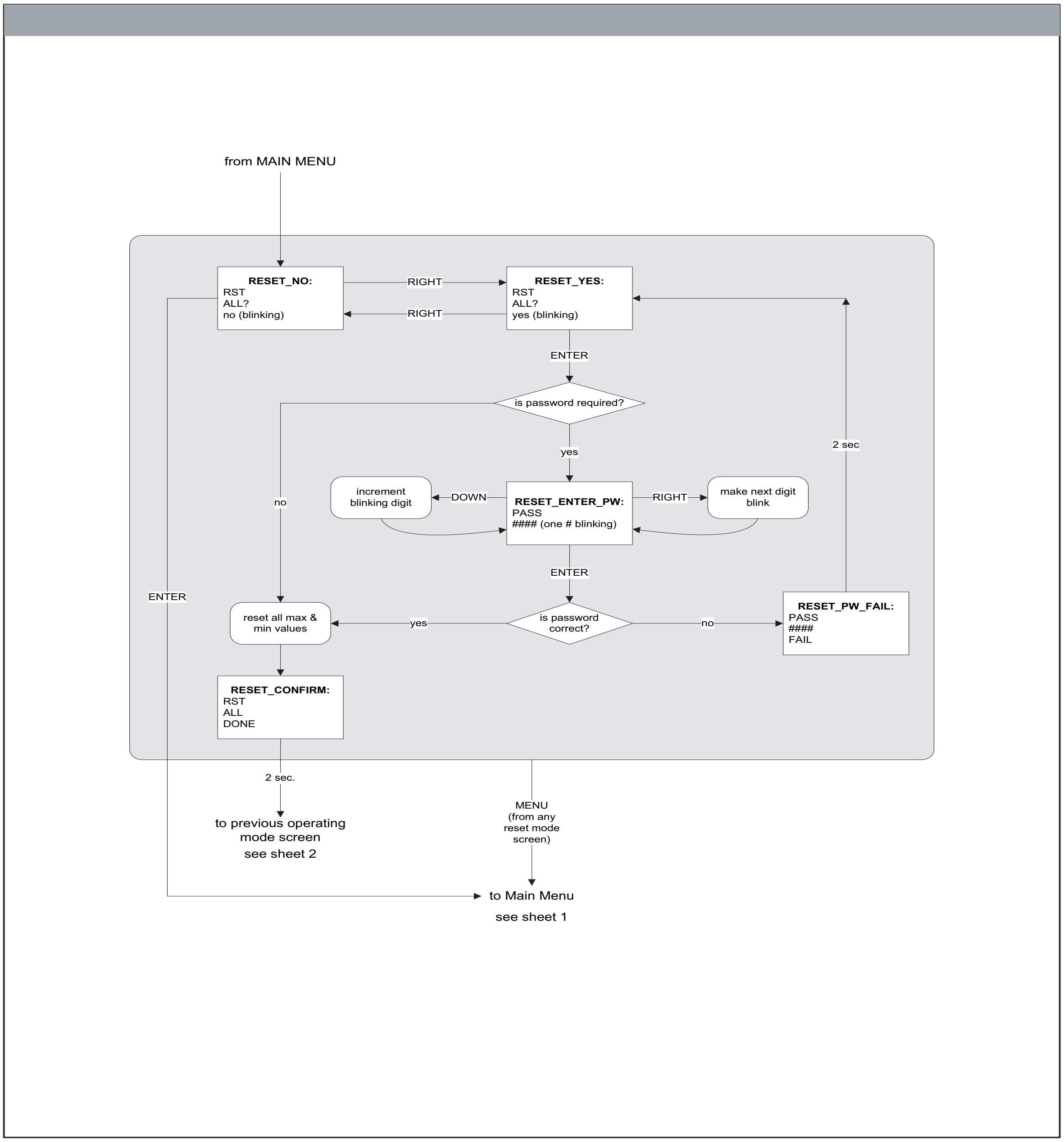
MENU	Returns to previous menu from any screen in any mode
ENTER	Indicates acceptance of the current screen and advances to the next one
DOWN, RIGHT	Navigation and edit buttons
Navigation:	No digits or legends are blinking. On a menu, down advances to the next menu selection, right does nothing. In a grid of screens, down advances to the next row, right advances to the next column. Rows, columns, and menus all navigate circularly.
Editing:	A digit or legend is blinking to indicate that it is eligible for change. When a digit is blinking, down increases the digit value, right moves to the next digit. When a legend is blinking, either button advances to the next choice legend.



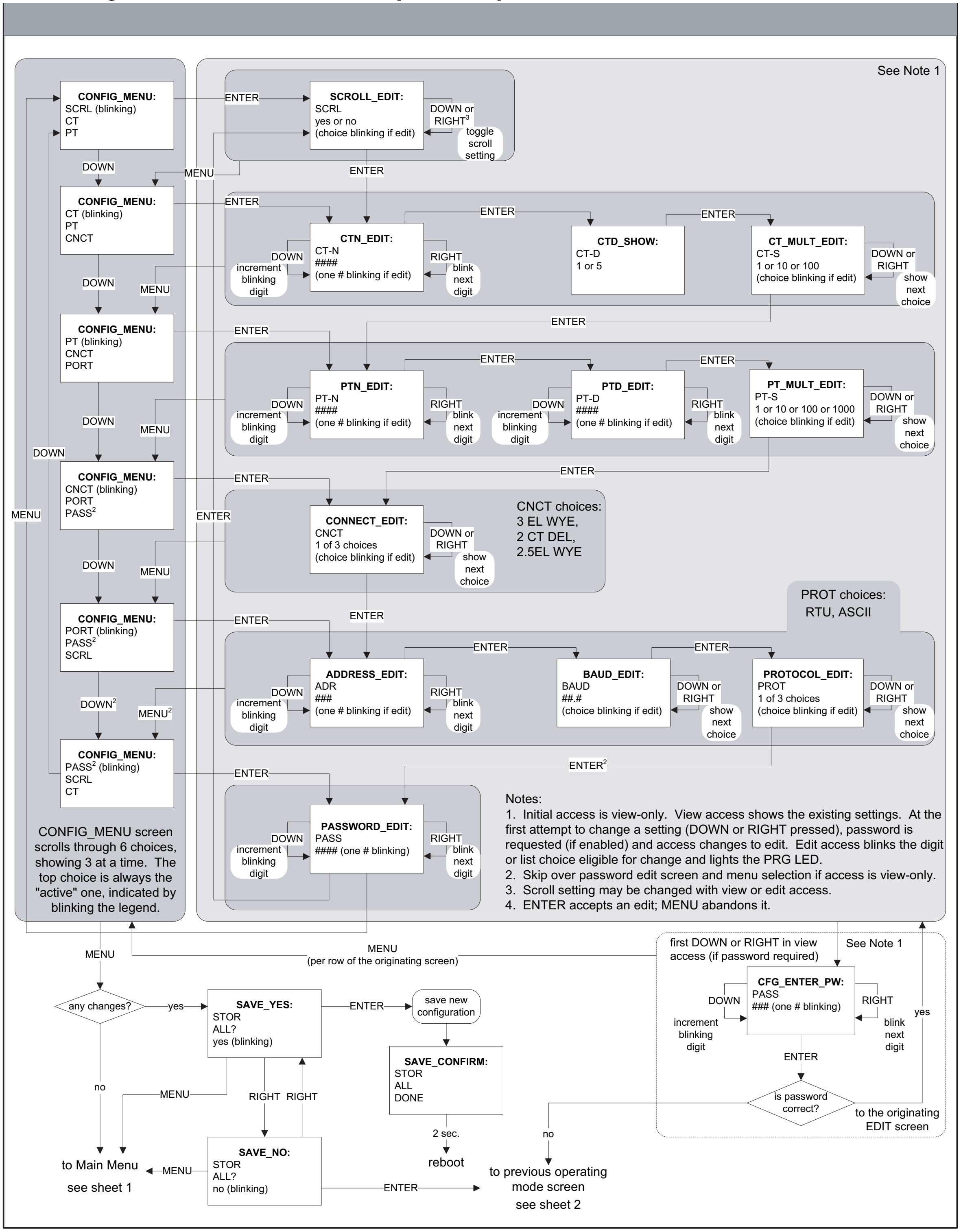
Operating Mode Screens (Sheet 2)



Reset Mode Screens (Sheet 3)



Configuration Mode Screens (Sheet 4)



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B: Shark® 100 Meter Modbus Map

B.1: Introduction

The Modbus map for the Shark® 100 meter gives details and information about the possible readings of the meter and about the programming of the meter. The Shark® 100 can be programmed using the buttons on the face plate of the meter (Chapter 6). The meter can also be programmed using software (Chapter 5).

B.2: Modbus Register Map Sections

The Shark® 100 Modbus register map includes the following sections:

Fixed Data Section, Registers 1- 47, details the Meter's Fixed Information

Meter Data Section, Registers 1000 - 5003, details the Meter's Readings, including Primary Readings, Energy Block, Demand Block, Maximum and Minimum Blocks, THD Block, Phase Angle Block and Status Block. Operating Mode readings are described in Section 6.2.6

Commands Section, Registers 20000 - 26011, details the Meter's Resets Block, Programming Block, Other Commands Block and Encryption Block

Programmable Settings Section, Registers 30000 - 30067, details the Meter's Basic Setups

Secondary Readings Section, Registers 40001 - 40100, details the Meter's Secondary Readings Setups

B.3: Data Formats

ASCII:	ASCII characters packed 2 per register in high, low order and without any termination characters.
SINT16/UINT16:	16-bit signed/unsigned integer.
SINT32/UINT32:	32-bit signed/unsigned integer spanning 2 registers. The lower-addressed register is the high order half.

FLOAT: 32-bit IEEE floating point number spanning 2 registers. The lower-addressed register is the high order half (i.e., contains the exponent).

B.4: Floating Point Values

Floating Point Values are represented in the following format:

Register	0																1															
Byte	0								1								0								1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
sign		exponent								mantissa																						

The formula to interpret a Floating Point Value is:

$-1^{sign} \times 2^{\,exponent-127} \times 1.mantissa = 0x0C4E11DB9$

$-1^{sign} \times 2^{\,137-127} \times 1\cdot 10000100011101101110 01$

$-1 \times 2^{10} \times 1.75871956$

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B9v							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	1	0	0	1
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m																
	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m																
sign		exponent								mantissa																						
1		0x089 + 137								0b011000010001110110111001																						

Formula Explanation:

C4E11DB9 (hex) 11000100 11100001 00011101 10111001 (binary)

The sign of the mantissa (and therefore the number) is 1, which represents a negative value.

The Exponent is 10001001 (binary) or 137 decimal.

The Exponent is a value in excess 127. So, the Exponent value is 10.

The Mantissa is 11000010001110110111001 binary.

With the implied leading 1, the Mantissa is (1).611DB9 (hex).

The Floating Point Representation is therefore -1.75871956 times 2 to the 10.

Decimal equivalent: -1800.929

NOTES:

- Exponent = the whole number before the decimal point.
- Mantissa = the positive fraction after the decimal point.

B.5: Modbus Register Map

The Shark® 100 meter's Modbus register map begins on the following page.

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Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Fixed Data Section							
Identification Block						read-only	
0000 - 0007	1 - 8	Meter Name	ASCII	16 char	none		8
0008 - 000F	9 - 16	Meter Serial Number	ASCII	16 char	none		8
0010 - 0010	17 - 17	Meter Type	UINT16	bit-mapped	-------t -----vvv	t = transducer model (1=yes, 0=no), vvv = V-switch(1 to 4)	1
0011 - 0012	18 - 19	Firmware Version	ASCII	4 char	none		2
0013 - 0013	20 - 20	Map Version	UINT16	0 to 65535	none		1
0014 - 0014	21 - 21	Meter Configuration	UINT16	bit-mapped	-------- --ffffff	ffffff = calibration frequency (50 or 60)	1
0015 - 0015	22 - 22	ASIC Version	UINT16	0-65535	none		1
0016 - 0026	23 - 39	Reserved					17
0027 - 002E	40 - 47	Reserved					8
						Block Size:	47
Meter Data Section[2]							
Primary Readings Block, 6 cycles (IEEE Floating Point)						read-only	
0383 - 0384	900 - 901	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
0385 - 0386	902 - 903	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
0387 - 0388	904 - 905	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
						Block Size:	6
Primary Readings Block, 60 cycles (IEEE Floating Point)						read-only	
03E7 - 03E8	1000 - 1001	Volts A-N	FLOAT	0 to 9999 M	volts		2
03E9 - 03EA	1002 - 1003	Volts B-N	FLOAT	0 to 9999 M	volts		2
03EB - 03EC	1004 - 1005	Volts C-N	FLOAT	0 to 9999 M	volts		2
03ED - 03EE	1006 - 1007	Volts A-B	FLOAT	0 to 9999 M	volts		2
03EF - 03F0	1008 - 1009	Volts B-C	FLOAT	0 to 9999 M	volts		2
03F1 - 03F2	1010 - 1011	Volts C-A	FLOAT	0 to 9999 M	volts		2
03F3 - 03F4	1012 - 1013	Amps A	FLOAT	0 to 9999 M	amps		2
03F5 - 03F6	1014 - 1015	Amps B	FLOAT	0 to 9999 M	amps		2
03F7 - 03F8	1016 - 1017	Amps C	FLOAT	0 to 9999 M	amps		2
03F9 - 03FA	1018 - 1019	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
03FB - 03FC	1020 - 1021	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
03FD - 03FE	1022 - 1023	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
03FF - 0400	1024 - 1025	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2
0401 - 0402	1026 - 1027	Frequency	FLOAT	0 to 65.00	Hz		2
0403 - 0404	1028 - 1029	Neutral Current	FLOAT	0 to 9999 M	amps		2
						Block Size:	30

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Primary Energy Block						read-only	
044B - 044C	1100 - 1101	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs	2
044D - 044E	1102 - 1103	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received is positive for "view as load", delivered is positive for "view as generator"	2
044F - 0450	1104 - 1105	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format		2
0451 - 0452	1106 - 1107	W-hours, Total	SINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
0453 - 0454	1108 - 1109	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* decimal point implied, per energy format	2
0455 - 0456	1110 - 1111	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
0457 - 0458	1112 - 1113	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format		2
0459 - 045A	1114 - 1115	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2
045B - 045C	1116 - 1117	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format	* see note 10	2
						Block Size:	18
Primary Demand Block (IEEE Floating Point)						read-only	
07CF - 07D0	2000 - 2001	Amps A, Average	FLOAT	0 to 9999 M	amps		2
07D1 - 07D2	2002 - 2003	Amps B, Average	FLOAT	0 to 9999 M	amps		2
07D3 - 07D4	2004 - 2005	Amps C, Average	FLOAT	0 to 9999 M	amps		2
07D5 - 07D6	2006 - 2007	Positive Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07D7 - 07D8	2008 - 2009	Positive VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07D9 - 07DA	2010 - 2011	Negative Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07DB - 07DC	2012 - 2013	Negative VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07DD - 07DE	2014 - 2015	VAs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VAs		2
07DF - 07E0	2016 - 2017	Positive PF, 3-Ph, Average	FLOAT	-1.00 to +1.00	none		2
07E1 - 07E2	2018 - 2019	Negative PF, 3-PF, Average	FLOAT	-1.00 to +1.00	none		2
						Block Size:	20
Primary Minimum Block (IEEE Floating Point)						read-only	
0BB7 - 0BB8	3000 - 3001	Volts A-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BB9 - 0BBA	3002 - 3003	Volts B-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBB - 0BBC	3004 - 3005	Volts C-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBD - 0BBE	3006 - 3007	Volts A-B, Minimum	FLOAT	0 to 9999 M	volts		2
0BBF - 0BC0	3008 - 3009	Volts B-C, Minimum	FLOAT	0 to 9999 M	volts		2
0BC1 - 0BC2	3010 - 3011	Volts C-A, Minimum	FLOAT	0 to 9999 M	volts		2
0BC3 - 0BC4	3012 - 3013	Amps A, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC5 - 0BC6	3014 - 3015	Amps B, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC7 - 0BC8	3016 - 3017	Amps C, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC9 - 0BCA	3018 - 3019	Positive Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCB - 0BCC	3020 - 3021	Positive VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BCD - 0BCE	3022 - 3023	Negative Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCF - 0BD0	3024 - 3025	Negative VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BD1 - 0BD2	3026 - 3027	VAs, 3-Ph, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0BD3 - 0BD4	3028 - 3029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
0BD5 - 0BD6	3030 - 3031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD7 - 0BD8	3032 - 3033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
Primary Maximum Block (IEEE Floating Point)						read-only	
0C1B - 0C1C	3100 - 3101	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1D - 0C1E	3102 - 3103	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1F - 0C20	3104 - 3105	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C21 - 0C22	3106 - 3107	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
0C23 - 0C24	3108 - 3109	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
0C25 - 0C26	3110 - 3111	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
0C27 - 0C28	3112 - 3113	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C29 - 0C2A	3114 - 3115	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2B - 0C2C	3116 - 3117	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2D - 0C2E	3118 - 3119	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C2F - 0C30	3120 - 3121	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C31 - 0C32	3122 - 3123	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C33 - 0C34	3124 - 3125	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C35 - 0C36	3126 - 3127	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0C37 - 0C38	3128 - 3129	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C39 - 0C3A	3130 - 3131	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C3B - 0C3C	3132 - 3133	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
THD Block[7, 13]						read-only	
0F9F - 0F9F	4000 - 4000	Volts A-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA0 - 0FA0	4001 - 4001	Volts B-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA1 - 0FA1	4002 - 4002	Volts C-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA2 - 0FA2	4003 - 4003	Amps A, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA3 - 0FA3	4004 - 4004	Amps B, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA4 - 0FA4	4005 - 4005	Amps C, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA5 - 0FA5	4006 - 4006	Phase A Current 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FA6 - 0FA6	4007 - 4007	Phase A Current 1st harmonic magnitude	UINT16	0 to 65535	none		1
0FA7 - 0FA7	4008 - 4008	Phase A Current 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FA8 - 0FA8	4009 - 4009	Phase A Current 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FA9 - 0FA9	4010 - 4010	Phase A Current 4th harmonic magnitude	UINT16	0 to 65535	none		1
0FAA - 0FAA	4011 - 4011	Phase A Current 5th harmonic magnitude	UINT16	0 to 65535	none		1
0FAB - 0FAB	4012 - 4012	Phase A Current 6th harmonic magnitude	UINT16	0 to 65535	none		1
0FAC - 0FAC	4013 - 4013	Phase A Current 7th harmonic magnitude	UINT16	0 to 65535	none		1
0FAD - 0FAD	4014 - 4014	Phase A Voltage 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FAE - 0FAE	4015 - 4015	Phase A Voltage 1st harmonic magnitude	UINT16	0 to 65535	none		1
0FAF - 0FAF	4016 - 4016	Phase A Voltage 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FB0 - 0FB0	4017 - 4017	Phase A Voltage 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FB1 - 0FB8	4018 - 4025	Phase B Current harmonic magnitudes	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FB9 - 0FBC	4026 - 4029	Phase B Voltage harmonic magnitudes	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
0FBD - 0FC4	4030 - 4037	Phase C Current harmonic magnitudes	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FC5 - 0FC8	4038 - 4041	Phase C Voltage harmonic magnitudes	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
						Block Size:	42

Modbus Address Hex	Modbus Address Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Phase Angle Block[14]						read-only	
1003 - 1003	4100 - 4100	Phase A Current	SINT16	-1800 to +1800	0.1 degree		1
1004 - 1004	4101 - 4101	Phase B Current	SINT16	-1800 to +1800	0.1 degree		1
1005 - 1005	4102 - 4102	Phase C Current	SINT16	-1800 to +1800	0.1 degree		1
1006 - 1006	4103 - 4103	Angle, Volts A-B	SINT16	-1800 to +1800	0.1 degree		1
1007 - 1007	4104 - 4104	Angle, Volts B-C	SINT16	-1800 to +1800	0.1 degree		1
1008 - 1008	4105 - 4105	Angle, Volts C-A	SINT16	-1800 to +1800	0.1 degree		1
						Block Size:	6
Status Block						read-only	
1387 - 1387	5000 - 5000	Meter Status	UINT16	bit-mapped	--exnpch ssssssss	exnpch = EEPROM block OK flags (e=energy, x=max, n=min, p=programmable settings, c=calibration, h=header), ssssssss = state (1=Run, 2=Limp, 10=Prog Set Update via buttons, 11=Prog Set Update via IrDA, 12=Prog Set Update via COM2)	1
1388 - 1388	5001 - 5001	Limits Status[7]	UINT16	bit-mapped	87654321 87654321	high byte is setpt 1, 0=in, 1=out low byte is setpt 2, 0=in, 1=out	1
1389 - 138A	5002 - 5003	Time Since Reset	UINT32	0 to 4294967294	4 msec	wraps around after max coun	2
						Block Size:	4
Commands Section[4]							
Resets Block[9]						write-only	
4E1F - 4E1F	20000 - 20000	Reset Max/Min Blocks	UINT16	password[5]			1
4E20 - 4E20	20001 - 20001	Reset Energy Accumulators	UINT16	password[5]			1
						Block Size:	2
Meter Programming Block						read/conditional write	
55EF - 55EF	22000 - 22000	Initiate Programmable Settings Update	UINT16	password[5]		meter enters PS update mode	1
55F0 - 55F0	22001 - 22001	Terminate Programmable Settings Update[3]	UINT16	any value		meter leaves PS update mode via reset	1
55F1 - 55F1	22002 - 22002	Calculate Programmable Settings Checksum[3]	UINT16			meter calculates checksum on RAM copy of PS block	1
55F2 - 55F2	22003 - 22003	Programmable Settings Checksum[3]	UINT16			read/write checksum register; PS block saved in EEPROM on write[8]	1
55F3 - 55F3	22004 - 22004	Write New Password[3]	UINT16	0000 to 9999		write-only register; always reads zero	1
59D7 - 59D7	23000 - 23000	Initiate Meter Firmware Reprogramming	UINT16	password[5]			1
						Block Size:	6

Modbus Address Hex	Modbus Address Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Other Commands Block						read/write	
61A7 - 61A7	25000 - 25000	Force Meter Restart	UINT16	password[5]		causes a watchdog reset, always reads 0	1
						Block Size:	1
Encryption Block						read/write	
658F - 659A	26000 - 26011	Perform a Secure Operation	UINT16			encrypted command to read password or change meter type	12
						Block Size:	12
Programmable Settings Section							
Basic Setups Block						write only in PS update mode	
752F - 752F	30000 - 30000	CT multiplier & denominator	UINT16	bit-mapped	dddddddd mmmmmmmm	high byte is denominator (1 or 5, read-only), low byte is multiplier (1, 10, or 100)	1
7530 - 7530	30001 - 30001	CT numerator	UINT16	1 to 9999	none		1
7531 - 7531	30002 - 30002	PT numerator	UINT16	1 to 9999	none		1
7532 - 7532	30003 - 30003	PT denominator	UINT16	1 to 9999	none		1
7533 - 7533	30004 - 30004	PT multiplier & hookup	UINT16	bit-mapped	mmmmmmmm MMMMhhhh	MMMMmmmmmmmm is PT multiplier (1, 10, 100, 1000), hhhh is hookup enumeration (0 = 3 element wye[9S], 1 = delta 2 CTs[5S], 3 = 2.5 element wye[6S])	1
7534 - 7534	30005 - 30005	Averaging Method	UINT16	bit-mapped	--iiiiii b----sss	iiiiii = interval (5,15,30,60) b = 0-block or 1-rolling sss = # subintervals (1,2,3,4)	1
7535 - 7535	30006 - 30006	Power & Energy Format	UINT16	bit-mapped	pppp--nn -eee-ddd	pppp = power scale (0-unit, 3-kilo, 6-mega, 8-auto) nn = number of energy digits (5-8 --> 0-3) eee = energy scale (0-unit, 3-kilo, 6-mega) ddd = energy digits after decimal point (0-6) See note 10.	1
7536 - 7536	30007 - 30007	Operating Mode Screen Enables	UINT16	bit-mapped	00000000 eeeeeeee	eeeeeeee = op mode screen rows on(1) or off(0), rows top to bottom are bits low order to high order	1
7537 - 753D	30008 - 30014	Reserved					7

Modbus Address Hex	Modbus Address Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
753E - 753E	30015 - 30015	User Settings Flags	UINT16	bit-mapped	---g--nn srp--wf-	g = enable alternate full scale bargraph current (1=on, 0=off) nn = number of phases for voltage & current screens (3=ABC, 2=AB, 1=A, 0=ABC) s = scroll (1=on, 0=off) r = password for reset in use (1=on, 0=off) p = password for configuration in use (1=on, 0=off) w = pwr dir (0-view as load, 1-view as generator) f = flip power factor sign (1=yes, 0=no)	1
753F - 753F	30016 - 30016	Full Scale Current (for load % bargraph)	UINT16	0 to 9999	none	If non-zero and user settings bit g is set, this value replaces CT numerator in the full scale current calculation.	1
7540 - 7547	30017 - 30024	Meter Designation	ASCII	16 char	none		8
7548 - 7548	30025 - 30025	COM1 setup	UINT16	bit-mapped	----dddd -0100110	dddd = reply delay (* 50 msec) ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600)	1
7549 - 7549	30026 - 30026	COM2 setup	UINT16	bit-mapped	----dddd -ppp-bbb		1
754A - 754A	30027 - 30027	COM2 address	UINT16	1 to 247	none		1
754B - 754B	30028 - 30028	Limit #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see notes 7, 11, 12)	1
754C - 754C	30029 - 30029	Limit #1 Out High Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "above" limit (LM1), see notes 11-12.	1
754D - 754D	30030 - 30030	Limit #1 In High Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "above" limit clears; normally less than or equal to the "above" setpoint; see notes 11-12.	1
754E - 754E	30031 - 30031	Limit #1 Out Low Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "below" limit (LM2), see notes 11-12.	1
754F - 754F	30032 - 30032	Limit #1 In Low Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "below" limit clears; normally greater than or equal to the "below" setpoint; see notes 11-12.	1
7550 - 7554	30033 - 30037	Limit #2	SINT16	same as Limit #1	same as Limit #1	same as Limit #1	5
7555 - 7559	30038 - 30042	Limit #3	SINT16				5
755A - 755E	30043 - 30047	Limit #4	SINT16				5
755F - 7563	30048 - 30052	Limit #5	SINT16				5
7564 - 7568	30053 - 30057	Limit #6	SINT16				5
7569 - 756D	30058 - 30062	Limit #7	SINT16				5
756E - 7572	30063 - 30067	Limit #8	SINT16				5
						Block Size:	68

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
12-Bit Readings Section							
12-Bit Block						read-only except as noted	
9C40 - 9C40	40001 - 40001	System Sanity Indicator	UINT16	0 or 1	none	0 indicates proper meter operatior	1
9C41 - 9C41	40002 - 40002	Volts A-N	UINT16	2047 to 4095	volts	2047= 0, 4095= +150	1
9C42 - 9C42	40003 - 40003	Volts B-N	UINT16	2047 to 4095	volts	volts = 150 * (register - 2047) / 2047	1
9C43 - 9C43	40004 - 40004	Volts C-N	UINT16	2047 to 4095	volts		1
9C44 - 9C44	40005 - 40005	Amps A	UINT16	0 to 4095	amps	0= -10, 2047= 0, 4095= +10	1
9C45 - 9C45	40006 - 40006	Amps B	UINT16	0 to 4095	amps	amps = 10 * (register - 2047) / 2047	1
9C46 - 9C46	40007 - 40007	Amps C	UINT16	0 to 4095	amps		1
9C47 - 9C47	40008 - 40008	Watts, 3-Ph total	UINT16	0 to 4095	watts	0= -3000, 2047= 0, 4095= +3000	1
9C48 - 9C48	40009 - 40009	VARs, 3-Ph total	UINT16	0 to 4095	VARs	watts, VARs, VAs =	1
9C49 - 9C49	40010 - 40010	VAs, 3-Ph total	UINT16	2047 to 4095	VAs	3000 * (register - 2047) / 2047	1
9C4A - 9C4A	40011 - 40011	Power Factor, 3-Ph total	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1 pf = (register - 2047) / 1000	1
9C4B - 9C4B	40012 - 40012	Frequency	UINT16	0 to 2730	Hz	0= 45 or less, 2047= 60, 2730= 65 or more freq = 45 + ((register / 4095) * 30)	1
9C4C - 9C4C	40013 - 40013	Volts A-B	UINT16	2047 to 4095	volts	2047= 0, 4095= +300	1
9C4D - 9C4D	40014 - 40014	Volts B-C	UINT16	2047 to 4095	volts	volts = 300 * (register - 2047) / 2047	1
9C4E - 9C4E	40015 - 40015	Volts C-A	UINT16	2047 to 4095	volts		1
9C4F - 9C4F	40016 - 40016	CT numerator	UINT16	1 to 9999	none		1
9C50 - 9C50	40017 - 40017	CT multiplier	UINT16	1, 10, 100	none	CT = numerator * multiplier / denominator	1
9C51 - 9C51	40018 - 40018	CT denominator	UINT16	1 or 5	none		1
9C52 - 9C52	40019 - 40019	PT numerator	UINT16	1 to 9999	none		1
9C53 - 9C53	40020 - 40020	PT multiplier	UINT16	1, 10, 100	none	PT = numerator * multiplier / denominator	1
9C54 - 9C54	40021 - 40021	PT denominator	UINT16	1 to 9999	none		1
9C55 - 9C56	40022 - 40023	W-hours, Positive	UINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
9C57 - 9C58	40024 - 40025	W-hours, Negative	UINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2
9C59 - 9C5A	40026 - 40027	VAR-hours, Positive	UINT32	0 to 99999999	VARh per energy format	* resolution of digit before decimal point =	2
9C5B - 9C5C	40028 - 40029	VAR-hours, Negative	UINT32	0 to 99999999	VARh per energy format	units, kilo, or mega, per energy format	2
9C5D - 9C5E	40030 - 40031	VA-hours	UINT32	0 to 99999999	VAh per energy format	* see note 10	2
9C5F - 9C5F	40032 - 40032	Neutral Current	UINT16	0 to 4095	amps	see Amps A/B/C above	1
9C60 - 9CA2	40033 - 40099	Reserved	N/A	N/A	none		67
9CA3 - 9CA3	40100 - 40100	Reset Energy Accumulators	UINT16	password[5]		write-only register; always reads as 0	1
						Block Size:	100

End of Map

Data Formats	
ASCII	ASCII characters packed 2 per register in high, low order and without any termination characters. For example, "Shark100" would be 4 registers containing 0x5378, 0x6172, 0x6B31, 0x3030.
SINT16 / UINT16	16-bit signed / unsigned integer.

Notes

1 All registers not explicitly listed in the table read as 0. Writes to these registers will be accepted but won't actually change the register (since it doesn't exist).

2 Meter Data Section items read as 0 until first readings are available or if the meter is not in operating mode. Writes to these registers will be accepted but won't actually change the register.

3 Register valid only in programmable settings update mode. In other modes these registers read as 0 and return an illegal data address exception if a write is attempted.

4 Meter command registers always read as 0. They may be written only when the meter is in a suitable mode. The registers return an illegal data address exception if a write is attempted in an incorrect mode.

5 If the password is incorrect, a valid response is returned but the command is not executed. Use 5555 for the password if passwords are disabled in the programmable settings.

6 M denotes a 1,000,000 multiplier.

7 Not applicable to Shark 100, V-Switch 1, 2, or 3

8 Writing this register causes data to be saved permanently in EEPROM. If there is an error while saving, a slave device failure exception is returned and programmable settings mode automatically terminates via reset.

9 Reset commands make no sense if the meter state is LIMP. An illegal function exception will be returned.

10 Energy registers should be reset after a format change.

11 Entities to be monitored against limits are identified by Modbus address. Entities occupying multiple Modbus registers, such as floating point values, are identified by the lower register address. If any of the 8 limits is unused, set its identifier to zero. If the indicated Modbus register is not used or is a non-sensical entity for limits, it will behave as an unused limit.

12 There are 2 setpoints per limit, one above and one below the expected range of values. LM1 is the "too high" limit, LM2 is "too low". The entity goes "out of limit" on LM1 when its value is greater than the setpoint. It remains "out of limit" until the value drops below the in threshold. LM2 works similarly, in the opposite direction. If limits in only one direction are of interest, set the in threshold on the "wrong" side of the setpoint. Limits are specified as % of full scale, where full scale is automatically set appropriately for the entity being monitored:

current	FS = CT numerator * CT multiplier
voltage	FS = PT numerator * PT multiplier
power	FS = CT numerator * CT multiplier * PT numerator * PT multiplier * 3 [* SQRT(3) for delta hookup]
frequency	FS = 60 (or 50)
power factor	FS = 1.0
percentage	FS = 100.0
angle	FS = 180.0

13 THD not available shows 65535 (=0xFFFF) in all THD and harmonic magnitude registers for the channel when V-switch=4. THD may be unavailable due to low V or I amplitude, or delta hookup (V only).

14 All 3 voltage angles are measured for Wye and Delta hookups. For 2.5 Element, Vac is measured and Vab & Vbc are calculated. If a voltage phase is missing, the two voltage angles in which it participates are set to zero. A and C phase current angles are measured for all hookups. B phase current angle is measured for Wye and is zero for other hookups. If a voltage phase is missing, its current angle is zero.

15 If any register in the programmable settings section is set to a value other than the acceptable value, the meter will stay in LIMP mode. Please read the comment section or the rangle for each register the programmable settings section for acceptable values.

16 If V-Switch is 1 or 2 and protocol (ppp) is set to "3" (DNP), the meter will use the Modbus RTU protocol as DNP is supported by v-Switch 3 and above.

C: Shark® 100 Meter DNP Map

C.1: Introduction

The Shark® 100 meter's DNP map shows the client-server relationship in the meter's use of DNP Protocol.

C.2: DNP Mapping (DNP-1 to DNP-2)

The Shark® 100 DNP Point Map follows.

Binary Output States, Control Relay Outputs, Binary Counters (Primary) and Analog Inputs are described on Page 1.

Internal Indication is described on Page 2.

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Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
Binary Output States								Read via Class 0 only
10	0	2	Reset Energy Counters	BYTE	Always 1	N/A	none	
10	1	2	Change to Modbus RTU Protocol	BYTE	Always 1	N/A	none	
Control Relay Outputs								
12	0	1	Reset Energy Counters	N/A	N/A	N/A	none	Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY.
12	1	1	Change to Modbus RTU Protocol	N/A	N/A	N/A	none	Responds to Function 6 (Direct Operate - No Ack), Qualifier Code 17x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY.
Binary Counters (Primary)								Read via Class 0 only
20	0	4	W-hours, Positive	UINT32	0 to 99999999	multiplier = $10^{(n-d)}$, where n and d are derived from the energy format. n = 0, 3, or 6 per energy format scale and d = number of decimal places.	W hr	example: energy format = 7.2K and W-hours counter = 1234567 n=3 (K scale), d=2 (2 digits after decimal point), multiplier = $10^{(3-2)} = 10^1 = 10$, so energy is 1234567 * 10 Whrs, or 12345.67 KWhrs
20	1	4	W-hours, Negative	UINT32	0 to 99999999		W hr	
20	2	4	VAR-hours, Positive	UINT32	0 to 99999999		VAR hr	
20	3	4	VAR-hours, Negative	UINT32	0 to 99999999		VAR hr	
20	4	4	VA-hours, Total	UINT32	0 to 99999999		VA hr	
Analog Inputs (Secondary)								Read via Class 0 only
30	0	5	Meter Health	SINT16	0 or 1	N/A	none	0 = OK
30	1	5	Volts A-N	SINT16	0 to 32767	(150 / 32768)	V	Values above 150V secondary read 32767.
30	2	5	Volts B-N	SINT16	0 to 32767	(150 / 32768)	V	
30	3	5	Volts C-N	SINT16	0 to 32767	(150 / 32768)	V	
30	4	5	Volts A-B	SINT16	0 to 32767	(300 / 32768)	V	Values above 300V secondary read 32767.
30	5	5	Volts B-C	SINT16	0 to 32767	(300 / 32768)	V	
30	6	5	Volts C-A	SINT16	0 to 32767	(300 / 32768)	V	
30	7	5	Amps A	SINT16	0 to 32767	(10 / 32768)	A	Values above 10A secondary read 32767.
30	8	5	Amps B	SINT16	0 to 32767	(10 / 32768)	A	
30	9	5	Amps C	SINT16	0 to 32767	(10 / 32768)	A	

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	10	5	Watts, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	11	5	VARs, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	12	5	VAs, 3-Ph total	SINT16	0 to +32767	(4500 / 32768)	VA	
30	13	5	Power Factor, 3-Ph total	SINT16	-1000 to +1000	0.001	none	
30	14	5	Frequency	SINT16	0 to 9999	0.01	Hz	
30	15	5	Positive Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	16	5	Positive VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	17	5	Negative Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	18	5	Negative VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	19	5	VAs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VA	
30	20	5	Angle, Phase A Current	SINT16	-1800 to +1800	0.1	degree	
30	21	5	Angle, Phase B Current	SINT16	-1800 to +1800	0.1	degree	
30	22	5	Angle, Phase C Current	SINT16	-1800 to +1800	0.1	degree	
30	23	5	Angle, Volts A-B	SINT16	-1800 to +1800	0.1	degree	
30	24	5	Angle, Volts B-C	SINT16	-1800 to +1800	0.1	degree	
30	25	5	Angle, Volts C-A	SINT16	-1800 to +1800	0.1	degree	
30	26	5	CT numerator	SINT16	1 to 9999	N/A	none	CT ratio = (numerator * multiplier) / denominator
30	27	5	CT multiplier	SINT16	1, 10, or 100	N/A	none	
30	28	5	CT denominator	SINT16	1 or 5	N/A	none	
30	29	5	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio = (numerator * multiplier) / denominator
30	30	5	PT multiplier	SINT16	1, 10, or 100	N/A	none	
30	31	5	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	5	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767.
Internal Indication								
80	0	1	Device Restart Bit	N/A	N/A	N/A	none	Clear via Function 2 (Write), Qualifier Code 0.

D: DNP 3.0 Protocol Assignments

DNP 3.0 protocol is available in the Shark® 100 meter if the meter is a V-3 or V-4 optioned unit. The meter must also be equipped with an RS485 port. The Shark® 100 meter dos not support DNP over Ethernet - only Modbus over Ethernet is available.

D.1: DNP Implementation

PHYSICAL LAYER

The Shark® 100 meter can use RS485 as the physical layer. This is accomplished by connecting a PC to the meter using the meter's RS485 connection (see Chapter 5).

RS485

RS485 provides multi-drop network communication capabilities. Multiple meters can be placed on the same bus, allowing for a Master device to communicate with any of the other devices. Appropriate network configuration and termination should be evaluated for each installation to insure optimal performance (see Chapter 5).

Communication Parameters

Shark® 100 meters communicate in DNP 3.0 using the following communication settings:

- 8 Data Bits
- No Parity
- 1 Stop Bit
- Baud Rates: 9600, 19200, 38400, 57600

D.2: Data Link Layer

The Data Link Layer for Shark® 100 meters is subject to the following considerations:

Control Field

The Control Byte contains several bits and a Function Code.

Control Bits

Communication directed to the meter should be Primary Master messages (DIR = 1, PRM = 1). Response will be primary Non-Master messages (DIR = 0, PRM = 1). Acknowledgment will be Secondary Non-Master messages (DIR = 0, PRM = 0).

Function Codes

Shark® 100 meters support all of the Function Codes for DNP 3.0.

Reset of Data Link (Function 0)

Before confirmed communication with a master device, the Data Link Layer must be reset. This is necessary after a meter has been restarted, either by applying power to the meter or reprogramming the meter. The meter must receive a RESET command before confirmed communication can take place. Unconfirmed communication is always possible and does not require a RESET.

User Data (Function 3)

After receiving a request for USER DATA, the meter generates a Data Link CONFIRMATION, signaling the reception of the request, before the actual request is processed. If a response is required, it is also sent as UNCONFIRMED USER DATA.

Unconfirmed User Data (Function 4)

After receiving a request for UNCONFIRMED USER DATA, if a response is required, it is sent as UNCONFIRMED USER DATA.

Address

DNP 3.0 allows for addresses from 0 - 65534 (0x0000 - 0xFFFE) for individual device identification, with the address 65535 (0xFFFF) defined as an all stations address. Shark® 100 meters' addresses are programmable from 0 - 247 (0x0000 - 0x00F7), and address 65535 (0xFFFF) is recognized as the all stations address.

D.3: Transport Layer

The Transport Layer as implemented on Shark® 100 meters is subject to the following considerations:

Transport Header

Multiple-frame messages are not allowed for Shark® 100 meters. Each Transport Header should indicate it is both the first frame (FIR = 1) as well as the final frame (FIN = 1).

D.4: Application Layer

The Application Layer contains a header (Request or Response Header, depending on direction) and data.

Application Headers

Application Headers contain the Application Control Field and the Function Code.

Application Control Field

Multiple-fragment messages are not allowed for Shark® 100 meters. Each Application Header should indicate it is both the first fragment (FIR = 1) as well as the final fragment (FIN = 1). Application-Level confirmation is not used by Shark® 100 meters.

Function Codes

The following Function codes are implemented on Shark® 100 meters.

Read (Function 1)

Objects supporting the READ function are:

- Binary Outputs (Object 10)
- Counters (Object 20)
- Analog Inputs (Object 30)
- Class (Object 60)

These Objects can be read either by requesting a specific Variation available as listed in this appendix, or by requesting Variation 0. READ requests for Variation 0 of an Object is fulfilled with the Variation listed in this appendix.

Write (Function 2)

Objects supporting the WRITE function are:

- Internal Indications (Object 80)

Direct Operate (Function 5)

Objects supporting the DIRECT OPERATE function are:

- Control Relay Output Block (Object 12)

Direct Operate - No Acknowledgment (Function 6)

Objects supporting the DIRECT OPERATE - NO ACKNOWLEDGMENT function are:

- Change to MODBUS RTU Protocol

Response (Function 129)

Application responses from Shark® 100 meters use the RESPONSE function.

Application Data

Application Data contains information about the Object and Variation, as well as the Qualifier and Range.

D.4.1: Object and Variation

The following Objects (Obj.) and Variations (Var.) are supported by Shark® 100 meters:

- Binary Output Status (Object 10, Variation 2) †
- Control Relay Output Block (Object 12, Variation 1)
- 32-Bit Binary Counter Without Flag (Object 20, Variation 5) †
- 16-Bit Analog Input Without Flag (Object 30, Variation 4) †

- Class 0 Data (Object 60, Variation 1) †
- Internal Indications (Object 80, Variation 1)

† READ requests for Variation 0 are honored with the above Variations.

D.4.1.1: Binary Output Status (Obj. 10, Var. 2)

Binary Output Status supports the following function:

Read (Function 1)

A READ request for Variation 0 is responded to with Variation 2.

Binary Output Status is used to communicate the following data measured by Shark® 100 meters:

Energy Reset State

Change to MODBUS RTU Protocol State

Energy Reset State (Point 0)

Shark® 100 meters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings can be reset using a Control Relay Output Block object (Object 12). The Binary Output Status point reports whether the Energy Readings are in the process of being reset, or are accumulating. Normally, readings are being accumulated - the state of this point reads as '0'. If readings are in the process of being reset, the state of this point reads as '1'.

Change to Modbus RTU Protocol State (Point 1)

Shark® 100 meters can of change from DNP Protocol to Modbus RTU Protocol. This enables the user to update the Device Profile of the meter (this does not change the meter’s Protocol setting). A meter reset brings communication back to DNP. A status reading of "1" equals Open, or de-energized. A reading of "0" equals Closed, or energized.

D.4.1.2: Control Relay Output Block (Obj. 12, Var. 1)

Control Relay Output Block supports the following functions:

Direct Operate (Function 5)

Direct Operate - No Acknowledgment (Function 6)

Control Relay Output Blocks are used for the following purposes:

Energy Reset

Change to MODBUS RTU Protocol

<u>Energy Reset (Point 0)</u>

As stated previously, Shark® 100 meters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings may be reset using Point 0.

<u>Change to Modbus RTU Protocol (Point 1)</u>

Refer to Section D.4.1.1 on the previous page for the Change to Modbus Protocol information.

Use of the DIRECT OPERATE (Function 5) function will operate only with the settings of Pulsed ON (Code = 1 of Control Code Field) once (Count = 0x01) for ON 1 millisecond and OFF 0 milliseconds.

D.4.1.3: 32-Bit Binary Counter Without Flag (Obj. 20, Var. 5)

Counters support the following functions:

Read (Function 1)

A READ request for Variation 0 is responded to with Variation 5.

Counters are used to communicate the following data measured by Shark® 100 meters:

Hour Readings

Hour Readings (Points 0 - 4)

Point	Readings	Unit
0	+W hour	Wh
1	-W hour	Wh
2	+VAR hour	VARh
3	-VAR hour	VARh
4	+VA hour	VAh

NOTE: These readings may be cleared by using the Control Relay Output Block (see previous Section D.4.1.2).

D.4.1.4: 16-Bit Analog Input Without Flag (Obj. 30, Var. 4)

Analog Inputs support the following functions:

Read (Function 1)

A READ request for Variation 0 is responded to with Variation 4.

Analog Inputs are used to communicate the following data measured by Shark® 100 meters:

- Health Check
- Phase-to-Neutral Voltage
- Phase-to-Phase Voltage

- Phase Current
- Total Power
- Three Phase Total VAs
- Three Phase Power Factor Total
- Frequency
- Three Phase +Watts Max Avg Demand
- Three Phase + VARs Max Avg Demand
- Three Phase -Watts Max Avg Demand
- Three Phase -VARs Max Avg Demand
- Three Phase VAs Max Avg Demand
- Angle, Phase Power
- Angle, Phase-to-Phase Voltage
- CT Numerator, Multiplier, Denominator
- PT Numerator, Multiplier, Denominator

Health Check (Point 0)

The Health Check point is used to indicate problems detected by the Shark® 100 meter. A value of zero (0x0000) indicates the meter does not detect a problem. Non-zero values indicate a detected anomaly.

Phase-to-Neutral Voltage (Points 1 - 3)

Point	Reading
1	Phase AN Voltage
2	Phase BN Voltage
3	Phase CN Voltage

These points are formatted as 2's complement fractions. They represent a fraction of a 150V Secondary input. Inputs of above 150V Secondary are pinned at 150V Secondary.

Phase-to-Phase Voltage (Points 4 - 6)

Point	Reading
4	Phase AB Voltage
5	Phase BC Voltage
6	Phase CA Voltage

These points are formatted as 2's complement fractions. They represent a fraction of a 300V Secondary input. Inputs of above 30 V Secondary are pinned at 300V Secondary.

Phase Current (Points 7 - 9)

Point	Reading
7	Phase A Current
8	Phase B Current
9	Phase C Current

These points are formatted as 2's complement fractions. They represent a fraction of a 10A Secondary input. Inputs of above 10A Secondary are pinned at 10A Secondary.

Total Power (Points 10 - 11)

Point	Reading
10	Total Watt
11	Total VAR

These points are formatted as 2's complement fractions. They represent a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/-3000W Secondary, respectively.

Total VA (Point 12)

Point	Reading
12	Total VA

This point is formatted as a 2's complement fraction. It represents a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/-3000W Secondary, respectively.

Power Factor (Point 13)

Point	Reading
13	Power Factor Total

This point is formatted as a 2's complement integer. It represents Power Factors from -1.000 (0x0FC18) to +1.000 (0x003E8). In Open Delta operation, Total Power Factor (Point 13) is always zero.

Frequency (Point 14)

Point	Reading
14	Frequency

This point is formatted as a 2's complement fraction. It represents the Frequency as measured on Phase A Voltage in units of cHz (centiHertz, 1/100 Hz). Inputs below 45.00 Hz are pinned at 0 (0x0000); inputs above 75.00 Hz are pinned at 9999 (0x270F).

Maximum Demands of Total Power (Points 15 - 19)

Point	Reading
15	Maximum Positive Demand Total Watts
16	Maximum Positive Demand Total VARs
17	Maximum Negative Demand Total Watts
18	Maximum Negative Demand Total VARs
19	Maximum Average Demand VAs

These points are formatted as 2's complement fractions. They represent a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/-3000W Secondary, respectively.

Phase Angle (Points 20 - 25)

Point	Reading
20	Phase A Current Angle
21	Phase B Current Angle
22	Phase C Current Angle
23	Volts A-B Angle
24	Volts B-C Angle
25	Volts C-A Angle

These points are formatted as 2's complement integers. They represent angles from -180.00 (0x0F8F8) to +180.00 (0x00708).

CT & PT Ratios (Points 26 - 31)

Point	Reading
26	CT Ratio Numerator
27	CT Ratio Multiplier
28	CT Ratio Denominator
29	PT Ratio Numerator
30	PT Ratio Multiplier
31	PT Ratio Denominator

These points are formatted as 2's complement integers. They can be used to convert from units in terms of the Secondary of a CT or PT into units in terms of the Primary of a CT or PT. The ratio of Numerator divided by Denominator is the ratio of Primary to Secondary.

Shark® 100 meters typically use Full Scales relating Primary Current to 5A and Primary Voltage to 120V. However, these Full scales can range from mAs to thousands of kAs, and from mVs, to thousands of kVs. Following are example settings:

CT Example Settings

200 Amps: Set the Ct-n value for 200 and the Ct-S value for 1.

800 Amps: Set the Ct-n value for 800 and the Ct-S value for 1.

2,000 Amps: Set the Ct-n value for 2000 and the Ct-S value for 1.

10,000 Amps:Set the Ct-n value for 1000 and the Ct-S value for 10.

NOTE: CT Denominator is fixed at 5 for 5A units; CT Denominator is fixed at 1 for 1A units.

PT Example Settings

277 Volts (Reads 277 Volts): Pt-n value is 277, Pt-d value is 277, Pt-S value is 1.

120 Volts (Reads 14,400 Volts): Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.

69 Volts (Reads 138,000 Volts): Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.

115 Volts (Reads 347,000 Volts): Pt-n value is 3470, Pt-d value is 115, Pt-S value is 100.

69 Volts (Reads 347,000 Volts): Pt-n value is 347, Pt-d value is 69, Pt-S value is 1000.

D.4.1.5: Class 0 Data (Obj. 60, Var. 1)

Class 0 Data supports the following functions:

Read (Function 1)

A request for Class 0 Data from a Shark® 100 meter returns three Object Headers. Specifically, it returns 16-Bit Analog Input Without Flags (Object 30, Variation 4), Points 0 - 31, followed by 32-Bit Counters Without Flags (Object 20, Variation 5), Points 0 - 4, followed by Binary Output Status (Object 10, Variation 2), Points 0 - 1. (There is NO Object 1.)

A request for Object 60, Variation 0 is treated as a request for Class 0 Data.

D.4.1.6: Internal Indications (Obj. 80, Var. 1)

Internal Indications support the following functions:

Write (Function 2)

Internal Indications may be indexed by Qualifier Code 0.

Device Restart (Point 0)

This bit is set whenever the meter resets. The polling device may clear this bit by Writing (Function 2) to Object 80, Point 0.

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E: Using the USB to IrDA Adapter CAB6490

E.1: Introduction

Com 1 of the Shark® 100 meter is the IrDA port, located on the face of the meter. One way to communicate with the IrDA port is with EIG's USB to IrDA Adapter CAB6490, which allows you to access the Shark® meter's data from a PC. This Appendix contains instructions for installing the USB to IrDA Adapter.

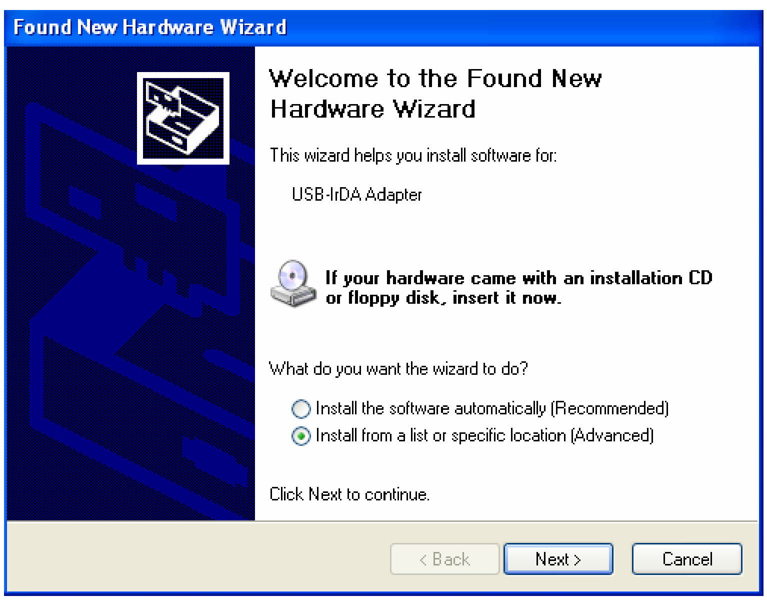
E.2: Installation Procedures

The USB to IrDA Adapter comes packaged with a USB cable and an Installation CD. Follow this procedure to install the Adapter on your PC.

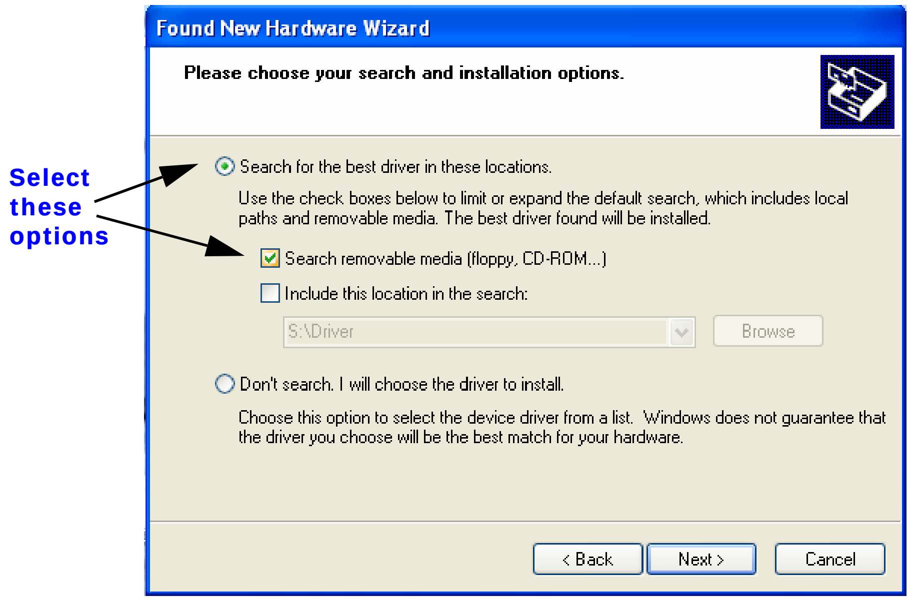
1. Connect the USB cable to the USB to IrDA Adapter, and plug the USB into your PC's USB port.

2. Insert the Installation CD into your PC's CD ROM drive.

3. You will see the screen shown below. The Found New Hardware Wizard allows you to install the software for the Adapter. Click the Radio Button next to **Install from a list or specific location**.



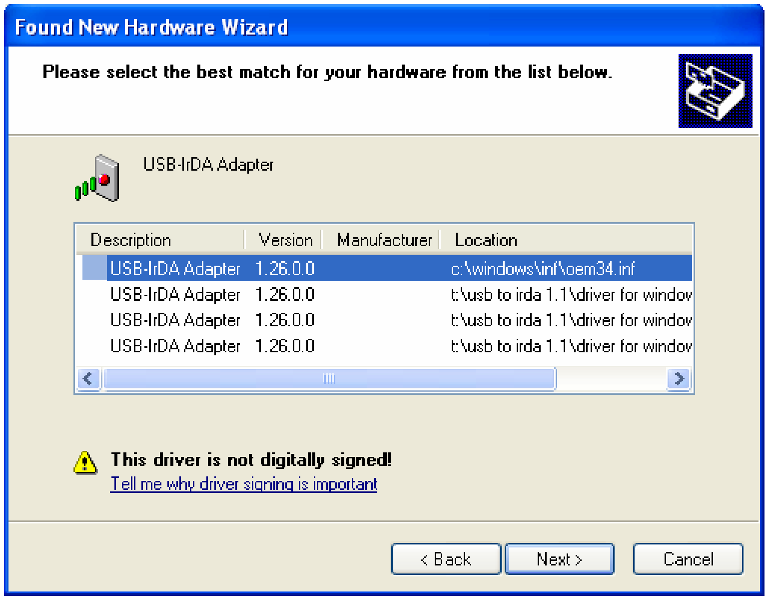
4. Click **Next**. You will see the screen shown on the next page.



5. Make sure the first Radio Button and the first Checkbox are selected, as shown above. These selections allow the Adapter's driver to be copied from the Installation disk to your PC.

6. Click **Next**. You will see the screen shown below.

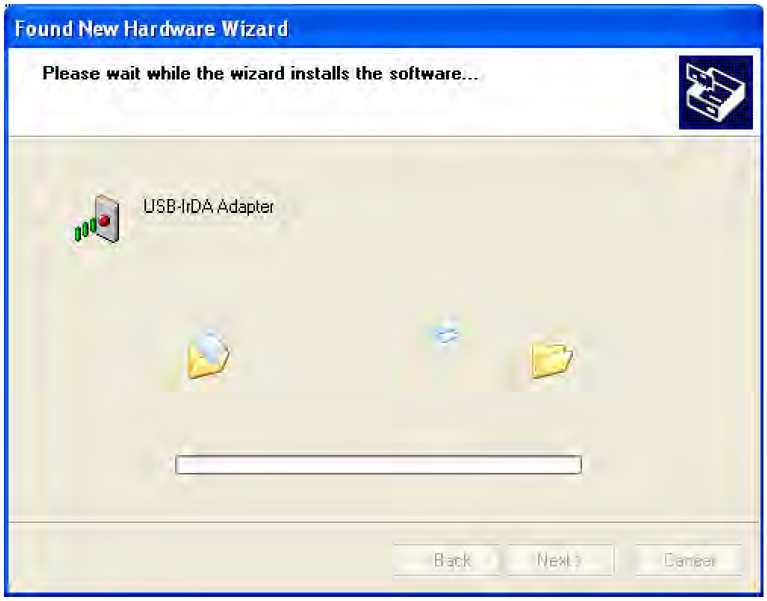
7. When the driver for the Adapter is found, you will see the screen shown on the next page.



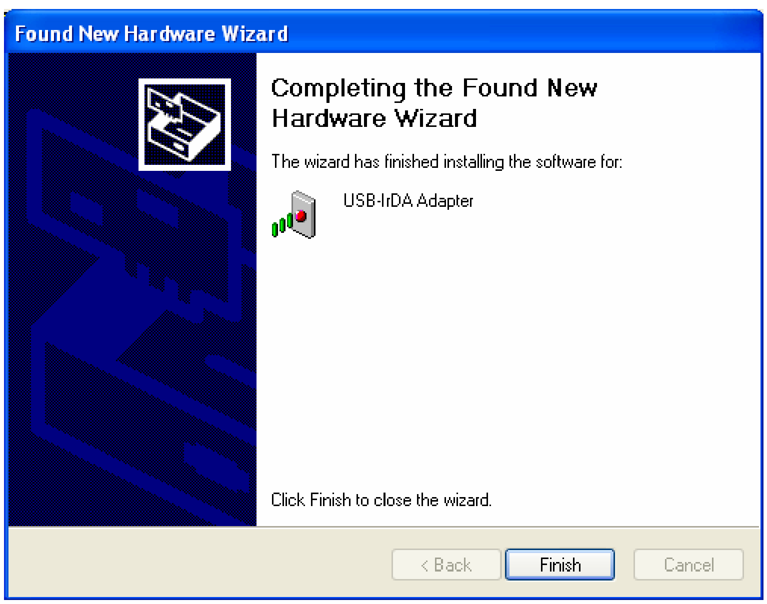
8. You do not need to be concerned about the message on the bottom of the screen. Click **Next** to continue with the installation.

9. You will see the two windows shown below. Click **Continue Anyway**.

10. You will see the screen shown below while the Adapter's driver is being installed on your PC.



11. When driver installation is complete, you will see the screen shown below.



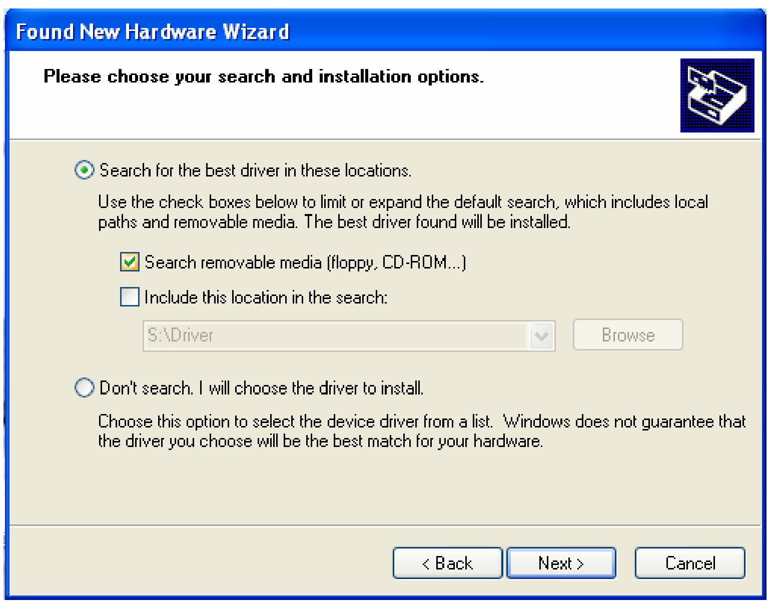
12. Click **Finish** to close the Found New Hardware Wizard.

IMPORTANT! Do NOT remove the Installation CD until the entire procedure has been completed.

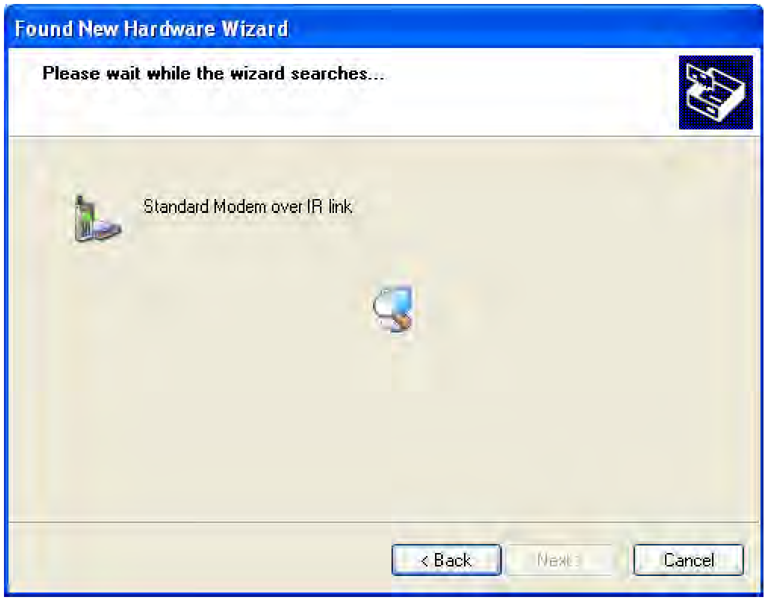
13. Position the USB to IrDA Adapter so that it points directly at the IrDA on the front of the Shark® 100 meter. It should be as close as possible to the meter, and not more than 15 inches/38 cm away from it.

14. The Found New Hardware Wizard screen opens again. This time, click the Radio Button next to Install the software automatically.

15. Click **Next**. You will see the screen shown below.

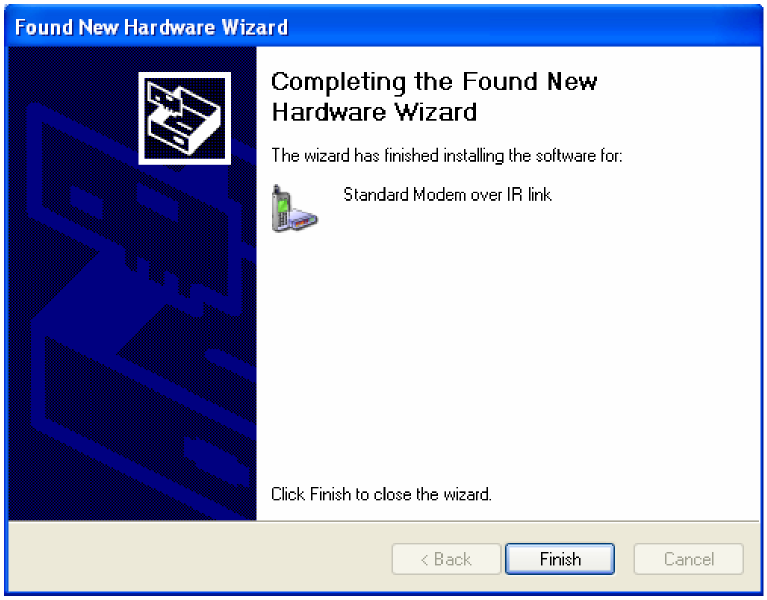


16. Make sure the first Radio Button and the first Checkbox are selected, as shown above screen. Click **Next**. You will see the two screens shown on the next page.


Found New Hardware Wizard
Please wait while the wizard searches...
Standard Modem over IR link
< Back
Next >
Cancel


Found New Hardware Wizard
Please wait while the wizard installs the software...
Standard Modem over IR link
< Back
Next >
Cancel

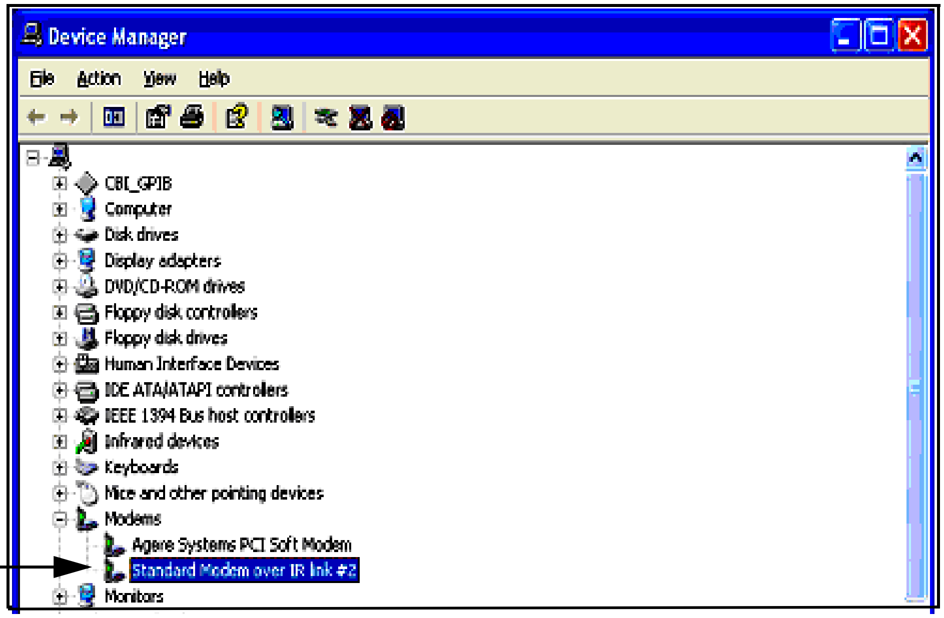
17.When installation is complete, you will see the screen shown below.



18.Click **Finish** to close the Found New Hardware Wizard.

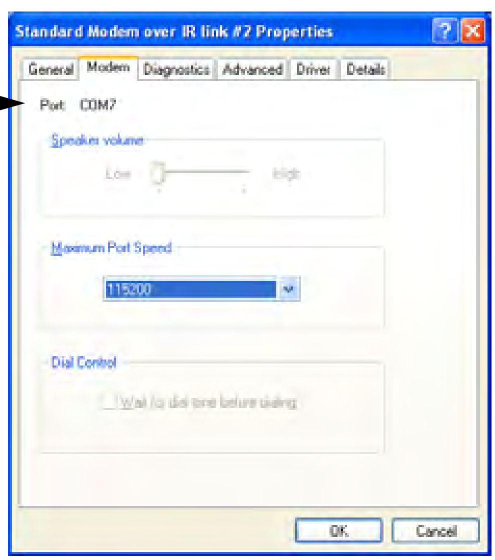
19.To verify that your Adapter has been installed properly, click **Start>Settings>Control Panel>System>Hardware>Device Manager**. The USB to IrDA Adapter should appear under both Infrared Devices and Modems (click on the + sign to display all configured modems). See the example screen on the next page.

NOTE: If the Adapter doesn't show up under Modems, move it away from the meter for a minute and then position it pointing at the IrDA, again.



20.Double-click on the Standard Modem over IR link (this is the USB to IrDA Adapter). You will see the Properties screen for the Adapter.

21.Click the Modem tab. The Com Port that the Adapter is using is displayed in the screen.



22.Use this Com Port to connect to the meter from your PC, using the Communicator EXT software. Refer to Chapter 5 of the Communicator EXT 3.0 User's Manual for detailed connection instructions.